THE

Psychological Review

EDITED BY

J. MARK BALDWIN
PRINCETON UNIVERSITY

AND

J. McKEEN CATTELL
COLUMBIA UNIVERSITY

WITH THE CO-OPERATION OF

ALFRED BINET, ÉCOLE DES HAUTES-ÉTUDES, PARIS; JOHN DEWEY, H. H. DONALDSON, UNIVERSITY OF CHICAGO; G. S. FULLERTON, UNIVERSITY OF PENNSYLVANIA; G. H. HOWISON, UNIVERSITY OF CALIFORNIA; JOSEPH JASTROW, UNIVERSITY OF WISCONSIN; G. T. LADD, YALE UNIVERSITY; HUGO MÜNSTERBERG, HARVARD UNIVERSITY; M. ALLEN STARR, COLLEGE OF PHYSICIANS AND SURGEONS, NEW YORK; CARL STUMPF, UNIVERSITY, BERLIN; JAMES SULLY, UNIVERSITY COLLEGE, LONDON.

H. C. WARREN, PRINCETON UNIVERSITY, *Associate Editor and Business Manager.*

Series of Monograph Supplements,

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Sociality and Sympathy.

An Introduction to the Ethics of Sympathy.

BY

JOSEPH W. L. JONES.

HEIDELBERG UNIVERSITY, TIFFIN, O.

[Thesis accepted for the Degree of Doctor of Philosophy in Princeton University, 1901.]

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CONTENTS.

DEFINITION OF SYMPATHY.

Sympathy is the feeling accompanying a representation or memory state when referred by the subject to an object. In this definition it is to be noted: (1) Sympathy, as such, is feeling. Accompanying as it does a representation, the feeling of sympathy is emotional. (2) It is the reference to an object which constitutes such feeling or emotion, sympathy. Although there can be no sympathy without emotion, yet it is in the being referred to an object that the emotion becomes a sympathy. (3) The reference is made by a sentient subject. Self-consciousness is here presupposed. Such a memory state as becomes sympathetic involves self-consciousness and stands so far for a personal experience. If we say that it is this represented experience—myself pictured—which is referred to the object, then it is the emotion, which is therein inherent, that constitutes the sympathy in the referred experience. (4) The object as cognized is distinguished by the sentient subject from itself in point of time and space. The object as an object of a sympathy must first have associated itself somehow with the representation out of which the sympathy springs. Whatever else the object of a sympathy may be, remains to be discussed.

This definition, since it limits sympathy to a high order of intelligence, will not by any means fall in with all other accounts of sympathy. Before we enter upon the investigation of the conditions of sympathy in the race it will be very well to compare briefly the present definition with several standard definitions of the phenomenon in question. The first factor of this definition, theories of sympathy generally are agreed upon. Sympathy is feeling—feeling with another. For instance, Professor Höffding[1] speaks of sympathy as 'an instinct to feel or to suffer with his kind.' Mr. A. Sutherland[2] calls sympathy 'that general tendency which makes men grieve at the pains

[1] 'Outlines of Psychology,' p. 244.

[2] 'The Origin and Growth of the Moral Instinct,' 1898, Vol. II., p. 302.

and rejoice in the pleasures of their fellows.' In the same way, Dr. James Sully[1] writes: "By sympathy is meant feeling excited by the manifestation of a like state in another, or as we may call it, concomitant feeling. * * * In sympathizing with a person, we are occupied with his feelings as such, and are ourselves in a state of resonant feeling."

The second factor of the definition is not generally accepted as an exclusive characteristic of sympathy. Most theories find an organic as well as a representative form of sympathy. Thus M. Th. Ribot[2] writes: "In its primitive form, sympathy is reflex, automatic, unconscious or very slightly conscious. * * * Sympathy is originally a property of living matter. As there is an organic memory and an organic sensitiveness, there is an organic sympathy." Sympathy considered as organic has been coördinated with imitation, when also considered as organic. The imitative factor in the sympathetic psychosis was observed as early as Spinoza: "He who conceives, that the object of his love is affected pleasurably or painfully, will himself be affected pleasurably or painfully; and the one or the other emotion will be less in the lover according as it is greater or less in the thing loved. * * * This imitation of emotions, when it is referred to pain, is called compassion."[3]

M. Ribot also observes:[4] "Between sympathy and imitation, at any rate in this primitive period, I see only one difference of aspect: sympathy everywhere marks the passive receptive side of the phenomenon—imitation its active and motor side." Dr. Sully may be quoted here also:[5] "The simplest manifestation of sympathy is to be found in the phenomenon known as the contagion of feeling. * * * It might be described as reinstatement of feeling through imitative motor discharges." Mr. Sutherland very aptly terms sympathy in this sense 'induced primary emotion.' Finally, Mr. Herbert Spencer,[6] followed also

[1] 'Human Mind,' 1892, Vol. II., pp. 106–7, 111.

[2] 'The Psychology of the Emotions,' 1897, pp. 231–2.

[3] 'Ethics,' Pt. III., Prop. XXI.; Prop. XXVII.; N. 1, R. H. M. Elwes tr., 1891.

[4] *Lib. cit.*, p. 231.

[5] *Lib. cit.*, Vol. II., p. 108.

[6] 'Principles of Psychology,' 1887, Vol. II., p. 563.

by both M. Ribot[1] and Dr. Sully,[2] grounds the spontaneous coöperations of lower animals in the imitative reaction upon excitation of such so-called sympathetic feeling. "The alarmed members of a flock, seen and heard by the rest, excite in the rest the emotion they are displaying; and the rest prompted by the emotions thus sympathetically excited begin to make like movements and sounds."

While recognizing or at least conceding an 'organic' sympathy, psychologists naturally lean toward sympathy as representative or reflective. For instance, Adam Smith[3] plainly recognizes the 'organic imitative' sympathy when he says: "When we see a stroke aimed, and just ready to fall upon the leg or arm of another person, we naturally shrink and draw back our own leg or own arm, and when it does fall, we feel it in some measure and are hurt by it as well as the sufferer." On the other hand he seems to make the entire psychosis representative, when he adds, p. 7: "Sympathy therefore does not arise so much from the view of the passion, as from that of the situation which excites it." Dr. Sully also speaks of lower and higher sympathy, and gives the 'higher and more complete form,' which he characterizes as 'sympathy with others,' far more attention. Professor F. Jodl[4] seems to rule out altogether the organic feeling upon imitative reaction, as a form of sympathy, when he says: "Wir fühlen nicht deshalb Mitleid mit einem Unglücklichen, Elenden, weil uns seine Leiden physischen Schmerz bereiten, sondern weil wir uns den Schmerz vorstellen, welchen er fühlt oder den wir an seiner Stelle fühlen müssten." Professor Alex. Bain also seems to commit himself completely to the representative sympathy[5] when he says: "Sympathy supposes the ability of representing the pleasures and pains belonging to other minds. * * * It is not enough to have emotional experience, there must also be the power of remembering that experience, or of effectively representing it to the mind. * * * We have seen that the fac-

[1] *Lib. cit.*, p. 232.
[2] *Lib. cit.*, p. 108.
[3] 'Theory of Moral Sentiments,' p. 4.
[4] 'Lehrbuch d. Psychologie,' 1896, S. 661.
[5] 'The Emotions and the Will,' 1875, pp. 66, 112, 120–1.

ulty is in a very great degree intellectual, that it rests upon intellectual operations."

As will be seen later on, the present definition of sympathy does not deny the fact of 'concomitant feeling' upon organic imitative reaction. It simply does not consider that such mere reduplication of feeling can be called sympathy. We do not make a distinction, such as Dr. Sully appears to make, between sympathy and sympathy with others, for we consider that the object — the 'with others' condition — is essential to any sympathy at all. In other words, it is this very reference of the experience-state to an object, which makes the feeling of the recalled experience a sympathy.

It is primarily because the reference-factor, being the central and essential mark of sympathy, involves of itself representative consciousness and self-consciousness, that we are obliged to ground sympathy in a representative state. The psychologists, who do not limit sympathy to the representation of an experience, naturally cannot consider the reference-factor essential to sympathy. Professor J. Mark Baldwin[1] expressly denies to sympathetic emotion this reference to an object. "There seems to be no difference in the conscious feeling of remembered pain and present sympathy, except a vague outward reference, which means only that it is not real pain now in me. * * * We may sympathize without sympathizing with anything. * * * The emotion of sympathy does not require an object at all. It acquires an object and then maintains itself by the emphasis of this object."

In the explanation of the definition which we may now undertake in some detail, we shall proceed by first giving an example of what purports to be a sympathy, according to the definition. Therein we shall show the operation of these several factors, and especially of the reference-factor, which is, we consider, the characteristic moment of a sympathetic reaction.

Suppose some person, *A*, to have had an encounter with a thornbush, such that the memory of the experience, the scratched hands, torn clothes and strained temper, is impressive and may upon occasion be readily reinstated. We find that the

[1] 'Hand Book of Psychology: Feeling and Will,' p. 189.

memory may be reinstated by two kinds of impressions: (1) by an impression in which the stimulus of the original experience (the thornbush and its attributes) predominates; (2) by an impression in which the thing *stimulated* (*A'* and his attributes—scratched hands, etc.) predominates. Assuming, at the outset, that 'the stimulus' cannot become an object of sympathy, then it is plain that where *A's* memory is aroused by 'the stimulus,' the object to which the ensuing sympathy attaches cannot be contained in this 'stimulus,' considered as an object of cognition. In such an event, there are in view of the problem three alternatives for sympathy. (1) *A's* emotion remains without sympathetic reference. That is, having no object to which the emotion may attach and become sympathetic, it remains merely the emotion of a represented experience. (2) *A acquires* an object for his sympathy; which acquired object may be of two kinds: (*a*) *A* may acquire an object by fixing attention upon himself; that is to say, by imagination the memory-image of himself is projected and thus it becomes an object for sympathy. (*b*) *A* may acquire an object for his sympathy solely by discursive thinking. This alternative, which supposes a representation of something in space and time, brings the inquiry about to the most natural and usual kind of object, which we shall now proceed to speak of.

The simplest situation for the rise of sympathy is given when the memory image is either aroused in the first place or rearoused (while *A* is ruminating upon it) by a presentation in which 'the thing-stimulated' predominates. Such a presentation, we will suppose, is something-*B*, that has just encountered a thornbush and shows the signs of the encounter to such an extent that *A* straightway recalls his own experience, or if he has already recalled it, has it reinforced upon his consciousness. Upon this supposition, we observe that *B* is an object of cognition, distinguished by *A* from himself in space and time. *B* is also a possible object of sympathy, for *B* has presented sufficiently 'the *A'* and his attributes' to have aroused *A's* memory of the experience, especially as contained in the thought of '*A'* and his attributes.'

Assuming now that *A* has in one and the same impression

a reminder of his own experience, and an object which is undergoing this class (to *A's* notion) of experience, we ask what is necessary, in order that this *B* may become an actual object of sympathy; that is to say, what is the relation of this presentation of *B's* experience to *A's* representation of his own experience, such that *A* will refer his own experience to *B*, and therein feel sympathetically toward *B*. We submit that it is the recognition of himself in object-*B* that will lead *A* to sympathize with *B;* or, to put it in the terms we are using, it is such a recognition of the '*A'* and his attributes' in the object-*B*, that *A's* representation will be forced from its original setting and will be referred to and centered in the object-*B*. We are now in a position to analyze in detail this entire sympathetic psychosis.

We shall consider in turn the nature of the feeling, the nature of the representation, and finally the nature of the recognition of self in the object-*B*. In the first place, when *A's* representation of an experience is aroused directly through the presented object-*B*, the feeling is *A's* own. This is inevitable, since it is indeed *A's* own experience, which *A* must first of all take cognizance of. In this feeling-complex, as in every feeling-complex accompanying a represented state, there are two distinct orders of feeling, which we should take account of in advance. On the physiological side, reactions peculiar to the encounter with the thornbush set in afresh; especially the characteristic motor attitude is reinstated, and therewith *A* has again the corresponding physiological feelings, which he experienced in the previous instance. These feelings are not, strictly speaking, remembered, but are actually felt anew. It is this reinstatement of the appropriate motor attitude upon the very awareness of another's motor attitude,[1] which underlies every sympathy; for it is the reinstatement of the physiological feeling which gives representation in the first place, as we see, its *presentative* affective tone. At the same time and along with this physiological process, we observe also the ideal or emotional feeling, accompanying the representation as such,

[1] This is the imitative aspect of the sympathetic psychosis, as propounded by Ribot and others (J. Mark Baldwin, 'Mental Development in the Child and Race,' 1895, ch. 6, § 4).

and it is *this* feeling-process which gives the representative state its representative or emotional affective tone. These two affective processes are contained in every representation, and thus they go to make up the content of a sympathy.

We consider next the nature of the representation, or rather the change which takes place in representation, when aroused by an object, which becomes also an object of sympathy. While *A's* memory-image is, in the first instance, simply a representation of his former experience, it quickly undergoes a change. The perception of *B*, linked up through old associations to the memory image, is assimilated to *A's* generic image of the thornbush experience, and transforms the old mental content — the simple memory of a thornbush-experience. We may call this the first stage of the recognition process. But *A* does not stop here, for (according to the hypothesis that *A* shall proceed to recognition) *B* is not something belonging to the general class of thornbush experiences, with only enough of '*A'* and his attributes' to arouse memory. *B mirrors*, so to speak, *A's* thought of '*A'* and his attributes'; and thus, possessing essential marks of *A's* represented experience (to *A's* notion), is now completely or 'absolutely'[1] assimilated to that class of experience. What is now implied in this act of recognition? "We have," writes Professor Baldwin,[2] "in the recognition of an object not only the identification of it as objectively the same, but also a feeling of 'warmth,' ownership, self-reference. We do not recognize a thing simply *for itself;* we recognize it *for ourselves.* It has become, in a sense, ours by having been present to us before." We observe that there would be such a self-reference if *A* had had no thornbush experience and were recognizing *B* principally for *B* himself. But *A* is recognizing *B* principally for *A* himself. That is to say that it is *A's* very self that is the object of recognition. Therefore, how 'warm' must be the sense of ownership, such that *A*, having assimilated *B's* experience to his own experience, also recognizes himself in *B*. We observe that the criterion of self-reference is strikingly present, and so far as the criterion goes in determining recog-

[1] On the meaning of the term 'absolute' recognition, J. Mark Baldwin, 'Mental Development in the Child and Race,' ch. 10, sec. 3; ch. 11, sec. 2.

[2] 'Mental Development in the Child and Race,' p. 317.

nition, it may be said that the recognition of self in an object is the crowning instance of the phenomenon of recognition.

We are now in a position to show how the reference of the represented experience with its feeling-accompaniments to the object *B*, is involved in the very act of recognition. On the one hand, *A's* representation of his experience, considered as mere memory, grows dim; for *A's* interest and attention is focused upon a presentation-*B*. On the other hand, *A's* representation of his experience, considered as a thought of '*A*' and his attributes,' grows clearer and more vivid, for the object-*B* mirrors essentially this very thought of *A*. Thus the representation is transmuted from its original setting as mere memory, to this presented setting, and becomes '*A*' and his attributes' in object *B*.[1] At the same time the feeling-accompaniment, aggravated by the heightened motor discharge upon the presentation of *B*, also shifts its center. *A* now feels pain not in terms of a mere remembered self, but in terms of the self, at the moment *presented* to him in *B*. Through the recognized '*A*' and his attributes' in *B*, the experience has indeed become actually *A's* again, but *A's* pain by what might be called the illusion of the sympathetic state is the pain of this alter ego-*B*. We say that *A* now has pain not as of a memory, but as of an actual experience; and yet it is not like any other actual experience, for the sensation-coefficient (the cutaneous and sense feelings) is lacking. It is *sui generis* among experiences, for the pain is felt centered in another being; and this is what we mean by sympathy.

With this result we have made out a case which illustrates the definition that sympathy is the pleasure or pain of a representation, when referred by the sentient subject to an object.

In the foregoing account of the sympathetic reference we have spoken as if there were but one self in question, self-*A*, which is referred from *A's* own person to object-*B*. This oneness of self is indeed the essential mark of sympathy. Thus Prof. Bain[2] speaks of 'the characteristic moment of the sympathetic impulse — the being laid hold of and engrossed by

[1] This may perhaps be considered an instance of the Law of Obliviscence as stated by Höffding, *lib. cit.*, p. 244.

[2] *Lib. cit.*, p. 121.

these suggested feelings as connected with another person; the taking that person altogether into our own mental grasp to the setting aside or exclusion of our own personality.' Green also, in the 'Introduction to Hume,' II., Sec. 40, says: "Sympathy involves such a conceived identity or unity in difference between the spectator's own person and the person of the other that the same impression in being determined by his consciousness of himself, is determined also by his consciousness of the other as an 'alter ego.' Thus sympathy * * * is found to involve the determination of pleasure and pain, not merely by self-consciousness, but by a self-consciousness which is also self-identification with another." At the same time it appears that the subject is conscious from first to last of a difference between himself and the object. Bain and Green alike imply this in their use of the notion of identity. Already in the very cognition, the subject distinguishes the object from his own body. Then when he comes to recognize himself in the object, there is again implied this difference. First, there is lacking certain essentials of the reality-coefficient, viz., the sense-stimulation in his own body, with the accompanying sense and cutaneous feelings. This emphasizes the initial difference between his own body and the object. Then there is seldom if ever an absolute blending of the subject's self with the object. We have been speaking as if the object were another person, and in such a case the subject at the very first and before the identification by recognition has set in naturally distinguishes in the object a self different from himself; but even where the object is not a person, but only, we will say, a body, and becomes only so much of a self (to the subject's notion) as the subject reads into it — even then, there will still remain this difference of selves, for the body as object cannot in nature be precisely the same as the self of the subject; and the subject, in seeing himself in this body, commits himself to seeing something both more and less than himself. Thus he is obliged, at the same time that he attributes a self-hood to the object, to postulate a different self from his own. We may say that along with the recognition which yields sympathy, there is always a distinction in the mind of the subject between himself

and the object-self; and while sympathy consists in the identification of subject and object, yet there is never an absolute blending of himself with the object-self in the subject's entire consciousness of the situation. This initial and fundamental difference between the subject's self and the object's self is something which can perhaps be understood to better advantage when we come to the history of sympathy in the race.

Considered in its broadest aspect, a sympathy is simply a reminiscence of my struggle for existence, where the reminiscence is embodied in another who is at the very moment in the struggle for existence. As a very important factor in the process of sympathy we have stated that the reminiscence or representation in terms of my own personality should grow dim and be displaced by the representation in terms of the presented personality; and in order that this substitution may take place, it is necessary that the presented personality occupy the focus of attention to the exclusion of my own personality. We have discussed the immediate conditions in *B*, and it may be well to mention a more remote, but no less essential, condition. *B*, no matter how recognizable he is, cannot readily become the actual object of recognition, if *A*, at the moment, is concerned with himself, his own interests, etc. We may lay it down as a law that, other things equal, the possibility of sympathy is in inverse ratio to my concern for myself at the moment. Obversely the possibility of sympathy is in direct proportion to my leisure from myself [1] from severe engrossing activity of my own. As Adam Smith has observed: [2] "Before we can feel much for others, we must in some measure be at ease ourselves." And Mr. Spencer more broadly: [3] "Sympathy can reach its full height only when there have ceased to be frequent occasions for anything like serious self-sacrifice." That is to say, sympathy flourishes in an atmosphere of rest from the struggle for existence. The deliverance from the sheer struggle for my own existence — the pleasurable sense of repose and peace with the world — these things determine the possibility of sympathy in even the most susceptible natures.

[1] Certainly 'the characteristic of being susceptible to the impressions of the senses generally' is another precondition (Bain, *lib. cit.*, p. 115).

[2] *Lib. cit.*, Pt. V., Ch. II., p. 297.

[3] 'Prin. of Ethics,' Pt. I., p. 251.

Before leaving this introductory part it will be useful to clear up one or two other points in connection with the conditions to sympathy in the consciousness of the subject. Some theorists speak as if it required some effort of the imagination in order to sympathize. Thus Dr. Sully,[1] defining his so-called 'higher' sympathy, writes: "Sympathy is the imaginative entering into others' feelings through recallings of our own similar experiences — sympathy is feeling with and for another, which involves an imaginative 'intuition' or realization of his affective state." For sympathy as we daily experience it, the imagination has indeed a most important function, yet from the trend of the argument it is clearly seen not to be essential to sympathy. In a systematic or habitual sympathy, that is at the same time a reflective sympathy, it is true that I sympathize by putting myself in another's place through an effort of the imagination; but this is not the case, nor is it necessary, in the simplest form of sympathy, as we have tried to define and illustrate it. To say that in sympathy I put myself in another's place, would be to say that I identify myself with another. But in the first instance rather the reverse is true, that when I sympathize the other is identified with myself. Suppose *B* is an explorer whose legs have been frozen off in Greenland. I, who have always lived in the temperate zone, do not readily put myself in *B's* place, yet in an instant I sympathize with *B*. There is no constructive imagination present. In the first outburst of sympathy I treat *B's* condition, not as it actually is to *B*, but as it looks to me. We say that my sympathy is spontaneous. It is a direct function of my consciousness of kind, the recognition of my most fundamental self in another.

So far as the sympathy alone is concerned I perceive only that something in another which is like myself in my own experience. Thus it is invariably the perception of some feature of myself (essential or unessential to the other's particular personal condition, is indifferent) which arouses my sympathy. We may say that the instant I sympathize I become the other, yet only the other so far as I perceive it to be myself. I appear for a moment to be losing my identity in sympathizing, yet as a

[1] *Lib. cit.*, Vol. II., pp. 86, 107.

matter of fact I am asserting it in the strongest terms. There are really only two ways in which imagination affects sympathy. Imagination intensifies and renders more intelligent a sympathy already operative. Then, in sympathy with a fictitious character or with one's self, imagination creates the object, and thus becomes a remote condition to sympathy.

Sympathy being in each and every instance a case of feeling, it tends inevitably to express itself. This expression is exhibited primarily in the lines of the face and movements of the head and body. Such 'diffusion' (Bain) of feeling which is the phenomenon of emotional expression, exists to a greater or less extent in every sympathy. It is the one order of 'observable activity,' by which we detect the presence of feeling, hence also the presence, under the conditions given, of sympathetic feeling.

Another, and for our problem a most important tendency of sympathetic expression, is exhibited in what may be called its volitional outgo. When one is so stimulated as to feel pleasure or pain on one's own account, the tendency is to promote the pleasure or inhibit the pain. Now when that pleasure or pain passes over or refers itself to another, the tendency persists and the sympathizer tends to act in the same manner. The sympathizer is wholly bound up in the one sympathized with, not because he is what he is, but because in the first instance the one sympathized with became identified with the one sympathizing. Therefore the sympathizer no longer remembers the pain or pleasure as in his own person, but — and this is the indefinable 'illusion' of the sympathetic attitude — he undergoes again the experience in the person of the other; and as he would promote the pleasure or inhibit the pain in his own person, so he must behave likewise to the other, which is himself as he perceives himself.

This tendency to express itself volitionally is bound up in every sympathy. It is often called vicarious sympathy, and is thus considered part and parcel of the sympathetic reaction. From this standpoint, one writer speaks of sympathy as 'the faculty of entering into human conditions, so that another's burdens become our own. Thus he who offers sympathy offers a part of himself.' Professor Bain[1] considers as part of sym-

[1] *Lib. cit.*, p. 111.

pathy 'to act out these feelings for behoof of that other, as if they were our own.' Being a matter of the motor consciousness, this volitional outgo cannot be considered by us a factor of sympathetic reaction itself, even though the worth of sympathy in ethical altruism is dependent upon this vicarious expression.

THE RISE OF SYMPATHY IN THE RACE.

CHAPTER I.

Preliminary Considerations.

In the foregoing introduction we have taken a phenomenon which is called by men generally a phenomenon of sympathy; and we have endeavored to define it closely. In the discussion which is to follow we must needs take for granted the accuracy of our analysis in this definition. We have furthermore called this phenomenon (here the difference of opinion arises) the type of all sympathy, and the definition of it as of universal application. Assuming for the present that this definition does cover any and every phenomenon of sympathy, the following discussion will endeavor to show the history of this phenomenon in the evolution of consciousness.

The inquiry, which is genetic and mainly phylogenetic, will take consciousness in its 'growing developmental activity,' and investigate in the successive stages of its history the factors which condition the possibility of sympathy, as we have defined it. Then, when that stage of life-history has been reached which coördinates these factors, we shall endeavor to show how they may bring a sympathy into being. The investigation, taken throughout its length and breadth, will justify us, we believe, in having confined sympathy to the particular lines indicated in the introduction.

There are one or two considerations which must be clearly recognized before we proceed.

1. Since we do not confine the term 'race' to the human orders, the term 'race-history' of consciousness will mean the evolution of consciousness, starting with its earliest beginnings in the lowest orders.[1]

2. It is impracticable for the present purpose to define the

[1] *Vide* J Mark Baldwin, 'Mental Development in the Child and Race,' Ch 1, Sec. 2.

evolution of consciousness according to the lines of organic evolution. Our position is that of M. Ribot,[1] whom we quote: "Without troubling ourselves about the frequent disagreement between zoölogical taxinomy and sociological psychology, we shall follow the ascending march of the social instinct, no matter in what order or class, or at what point of the genealogical tree it shows itself."

3. According to the genetic method, as here conceived, we are not concerned, first of all, with pointing out any particular instance of sympathy in the race. Such an inquiry would result in finding merely the earliest *observable* instance, not the rise or actual first instance, which is anterior and non-observable. We simply determine when sympathy arises in the race, by determining when the causes are first coördinated. That will yield indeed the first instance, yet far too feeble for actual observation.

The most general and fundamental factor in the state of consciousness immediately underlying a sympathy, is the consciousness of kind. "The consciousness of kind," writes Professor F. H. Giddings,[2] "is a state of consciousness in which any being recognizes another conscious being as of like kind with itself." The recognition of kind here denotes that the subject in his consciousness of such an object is conscious of himself in that object.[3] This state of consciousness has already been treated as the fundamental condition of the sympathetic reaction, and the ensuing discussion will hinge about the genesis and evolution of the consciousness of kind considered as just such a recognition of self in another. At the same time, as sympathy is not a simple conscious process, but a complex of conscious processes, there are also certain affective factors (feeling of attachment, tenderness) to be taken into consider-

[1] *Lib. cit.*, p. 276. *Vide* also Romanes, 'Mental Evolution in Animals,' p. 248.

[2] 'Principles of Sociology,' 1896, p. 17.

[3] A. T. Ormond, 'Foundations of Knowledge,' p. 289. 'The sense of kind is the sense of that which is congruous with the sense of self'; also, 'Consciousness of kind is consciousness of self, however vague, as having something in common with another.' (Baldwin in his 'Dictionary of Philosophy and Psychology,' art. 'Consc. of Kind.' This work is hereafter referred to under the abbreviation 'B's Dict. of Philos.')

ation before consciousness can be fully capable of sympathy. The investigation aims: (1) To trace up consciousness to the point where the consciousness of kind emerges; (2) to explain and connect up the affective factors with the consciousness of kind; finally, to show how, out of such a conscious-complex, sympathy may arise and function.

If we consider that consciousness of kind, as defined, may mean in its broadest sense the consciousness of a resemblance, then it appears that the object's resemblance to the subject must be the great outlying fact in the problem.[1] Yet assuming this fact as the starting point of the investigation, we are immediately confronted with various questions as to the meaning of resemblance. (1) Is the resemblance imaginary as well as real? (2) Is the resemblance both organic and representative? (3) What are the conditions of life in which the resemblance inheres?

In adult consciousness the resemblance underlying the consciousness of the resemblance may be either real or imaginary. The object may actually resemble the subject, and thus, for the sake of simplicity, we considered it in the definition of sympathy. On the other hand, it may happen that the subject has read his own feelings into an object, or finally, even the object itself may be quite imaginary. For example, one reads of the poet's sympathy with 'the crags and peaks,' the trees and the running brooks, and sympathy with the personalities of fiction is normal to an imaginative mind. In such cases the subject establishes a resemblance by having already read himself into the object through sheer imaginative activity. Since the problem before us is the investigation of sympathy in the race, where such imagination does not factor, the cases of what may be called 'created object' fall out of consideration. The first question is therefore answered by saying that the resemblance of creatures in the phylogenetic series is always an actual fact.

[1] *Cf.* F. H. Giddings' formulation of consciousness of kind in 'B's Dict. of Philos.,' art. 'Consciousness of Kind.' Upon the above statement the following bears especially: 'The consciousness of kind is awakened by the presence or thought of an individual who, in important respects, resembles oneself.'

The answer to the second question depends upon where we start in the phylogeny to trace up the conditions to the consciousness of kind. Certainly the consciousness of kind implies the function of representation with all that representation involves;[1] and furthermore, since we are speaking of resemblance as an actual fact, it is difficult to see how a creature can be conscious of his resemblance to another unless that resemblance be also representative. Hence a representative resemblance is the fact immediately underlying the consciousness of the resemblance, considered as consciousness of kind. On the other hand, we should fail utterly of understanding representative resemblance and its meaning for consciousness of kind, without thoroughly investigating its ground and precondition in the organic resemblance of creatures. For this reason the organic resemblance of creatures will be the proper starting point of the investigation.[2]

As to the biological conditions of resemblance, when we consider that at the primitive period of which we are speaking mutual resemblance simply implies that creatures have reacted to the same conditions in the same way, it is plain that this factor inheres in the very nature of what we call species. Therefore, the term 'resemblance' will be used coextensively with the term species.[3]

Gathering together these three considerations about the character of resemblance in phylogeny, we arrive at this preliminary determination upon the investigation. Inasmuch as creatures must actually resemble each other in order to the consciousness of kind, and inasmuch as actual resemblance means being of the same species, the investigation is not hampered by any apprehension that consciousness of kind will first take its rise among creatures of different species. This limitation also shows—at least in the earlier manifestations of the consciousness of kind—what we mean by 'kind.' Until otherwise defined

[1] *Vide* p. 43 f.

[2] Obviously this is a resemblance only to the observer. If we speak of consciousness of kind at this period it would be termed an organic consciousness of kind. As Professor Baldwin has remarked: "The creatures have consciousness which in some way reflects the resemblance without the actual consciousness of the resemblance taking place." (*Vide* 'Mental Development in the Child and the Race,' p. 320.)

[3] *Cf.* 'B's Dict. of Philos.,' Art. 'Kind (in Biology).'

'kind' means 'species,' and a resemblance between individuals neither more nor less thoroughgoing and essential than the resemblance which goes with being of the same species. The actual task of investigation takes, as its starting point, the period of organic resemblance among creatures, but since the creatures are of the same species, the resemblance is a matter of the entire creature; and we find ourselves actually starting with the period of organic consciousness pure and simple.

CHAPTER II.

Rise of the Social Relationship.

We now pass on to the end object of the investigation contained in the question, how creatures thus resembling one another become conscious of the fact. Starting, as we have done, with organic consciousness, it is obvious that a growth of consciousness into the representative stage is necessary, in order to consciousness of kind. It is also obvious that the conditions of growth from the organic to the representative consciousness, considered in and of themselves, are not sufficient to bring creatures to a consciousness of kind. The impulse of self-conservation is found at this, the organic period, expressed wholly in terms of the creature's own resources; and under the conditions necessary merely for the growth of the representative power, so it would remain. The creature would appear like a closed circle, completely individualistic and 'self' centered, in his expression of the impulse of self-conservation; he would never come into a position where he could observe his fellow-creatures and become conscious of kind.

In order to the consciousness of kind, there must first of all obtain a certain interaction of activity (habitual attitudes) among creatures of a species, whereby creatures become forcibly conscious of each other. This interaction, as we show, may take the form either of opposition or of coöperation. While the interaction of opposition[1] (as well as the interaction of coöperation) may possibly give rise to a consciousness of kind among creatures, yet this possibility, being in any case an affair of later mental evolution, falls out of consideration in this investigation, which has to do with origins.

Interaction of coöperation is another name for a social relationship in its simplest aspect. By a social relationship we

[1] A. T. Ormond (*lib. cit.*, pp. 194, 195) uses the term 'Collision of Agencies,' *cf.* with F. H. Giddings, 'Prin. of Soc.,' p. 109.

understand in general such a relationship as requires individuals to partake of or share in one another's experiences or life-interests, directed toward a common end. More particularly, for the problem in hand, a relationship, in order to be social, requires that any individual's impulse of self-conservation, expressed in the form of some habitual attitude, shall be modified so as to include, to a greater or less extent, all other similar habitual attitudes, and all others shall in the same way include it. Thus when we speak of a social relationship we shall mean in the first instance just this alteration of the impulse of self-conservation whereby creatures come into such relations as will make the consciousness of kind possible. Others, like Mr. Spencer,[1] appear to find the rise of sociality in the very presence of creatures together, while the *actions* — we mean those which Mr. Spencer characterizes as having 'a marked significance' — the actions of others like itself, serve merely to strengthen the social relationship already operative. We give the feeling of inclination,[2] springing out of mere 'presence,' full credit for being at the root of the social consciousness. We prefer, however, to fix the actual rise of social consciousness at the point of some distinct *relationship*, which we consider must be a matter of *activity*, to which the pleasure of mere presence is auxiliary.[3]

The first part of this investigation will endeavor to determine (1) the rise of social relationship and the corresponding social consciousness; (2) the evolution of the social consciousness up to the point where the consciousness of kind emerges. Then it will be a comparatively simple matter to show the rise of sympathy.

Following out the lines already laid down we assume as our starting point: (1) Each creature is impelled to conserve himself simply and solely through his own resources. This, as explained above, is the significance of the pre-social state. (2)

[1] 'Prin. of Psych.,' Vol. II., pp. 560–3.

[2] *Vide* p. 23.

[3] Ribot (*lib. cit.*, p. 283): 'Social tendencies arise from the nature of things, from the conditions of the animal's existence; they are not based on pleasure but on the unconscious affirmations of the will-to-live; they are auxiliary to the instinct of conservation.'

The creatures that are to become socially related are necessarily of the same species. This is implied in the very definition of the term 'social relationship.' There does exist, indeed, a relationship between the hippopotamus and the hippopotamus-bird, for example, but the relationship is not and cannot be social, for it is not a mutual or reciprocal relationship between 'creatures engaged in the same action' (Espinas). But creatures engaged in the same line of action have the same order of needs; they are, in other words, of the same species. Speaking genetically, as we have already determined that consciousness of kind is possible only among creatures of the same species, so we now determine that a social relationship is only possible among creatures of the same species. (3) The creatures of the species have attained, on the one hand, to some specialization of sense-function and also to memory that is simple revival, in distinction from the memory-image and recognition;[1] creatures have attained, on the other hand, to motor processes, which are instincts in distinction from consciously initiated adjustments. Corresponding to these instinctive motor processes, we assume also characteristic forms of emotional expression. This is a sufficiently adequate statement of organic consciousness, as we here conceive it.

Feeling of Inclination.

Taking life at the earliest stage of mental evolution possible under the conditions named,[2] we find that the individual, in the struggle for existence, reacts upon the creatures of his environment, each after its kind. Some the individual regards with pain; others he regards with pleasure. To the first class belong (besides the creatures that prey upon him as their natural food) the members of the individual's own species, in so far as they collide with him in the struggle for existence. The pain they cause him contracts the vital processes. In their vicinity,

[1] By this phase of memory we mean what Professor Baldwin (*lib. cit.*, p. 321) calls 'a first degree association.' It is 'memory of the organic type without recognition.'

[2] We are speaking here of consciousness at a stage of mental evolution found in almost the lowest animals—say at the period of the cœlenterata (cf. with date of 'social' organic imitation, p. 25 f).

under such circumstances, inhibition is the law of his life. To the second class belong all creatures of any species which in any way expand and accelerate the life processes of the individual. They may give pleasure because the creature needs them for food; they may give pleasure because he finds them useful in defense; finally, they may give pleasure simply because, having always been in contact with them, positive pleasure in their presence has followed upon former indifference. In this last case there springs up in the individual a certain feeling of inclination toward these other creatures for no cause whatever than that he has always been thrown in with them.

Conspicuous among creatures of this class belong (so far as they do not fall within the first class) the other members of the creature's own species. In the first instance, the individual, by the very fact that he happens to live his whole life through in constant contact with these other creatures like himself, must to a greater or less extent adjust himself to their presence, so that if they should be suddenly removed he must surely feel discomfort.[1] This we may say without meaning *necessarily* that they are positively helpful to the creature in the struggle for existence, or that they are regarded by him as having a common nature with himself. It is, as we say, merely an adjustment to one constant quantity in his life-condition.

While this is not the social relationship, yet the social relationship has its roots in this mere — we might almost say accidental — life together of any species. As M. Topinard[2] has observed, "All assemblages of animals, whatever may be the social form in which they have culminated, began as indifferent assemblages. Vague habits were unconsciously established between a few individuals, and pleasure resulted. The habits were confirmed, and the pleasure grew. The social spirit was the result." Thus there arises out of this indifference, and gradually as the evolution of conscious life, the feeling of inclination among the individuals of a species, from mere living in

[1] Spencer (*lib. cit.*, Vol. II., p. 561): "The perception of kindred beings, perpetually seen, heard and smelt, will come to form a predominant part of consciousness—so predominant a part, that absence of it will inevitably cause discomfort."

[2] *Monist*, January, 1897, 'Science and Faith,' p. 244.

propinquity; and this is the precursor of the social consciousness.

The feeling of inclination springs out of a passive contact, or as Mr. Spencer terms it[1] a 'passive association,' of the individual with the kind. According to the test of a social relationship already laid down, we know that, even though an individual be felt by any other individual as something neither indifferent nor yet positively hostile, yet if that individual in the gratification of self-conservation still remain without the pale of another's impulse of self-conservation, or so far as it so remains, it cannot be said to have entered into social relations with that other creature. We must therefore conclude that we have not found in the feeling of inclination a real index to the rise of a social relationship. In order to discover such an index, the attention must be fastened directly upon the impulse of self-conservation, as expressed in habitual attitudes.

As preliminary to an examination of the creature in the active struggle for existence, we may make the following important discrimination. Recollecting that the very reason why creatures do not become conscious of kind (under the sole conditions of growth from the organic to the representative stage) comes of their primordial individualism, then any form of activity which, in interaction,[2] emphasizes this separate singleness of creatures by retarding life processes (interaction of opposition), cannot, at least at this initial stage, contribute the social relationship; contrariwise, any form of activity which, in interaction, diminishes the separate singleness of creatures, by accelerating life processes (interaction of coöperation), contributes just so far the social relationship. In view of this discrimination, it is clear that if we observe the habitual activities of creatures in interaction, and determine which are accelerated by such interaction, we shall at the same time determine the interaction of coöperation and the location of the social relationship. Thereupon we may show positively how those attitudes of the creature which are accelerated by the others of his species, become reformed or readjusted to include all similar attitudes. When

[1] 'Princ. of Ethics,' Pt. I., sec. 52.
[2] *Vide* p. 19.

this conclusion has been reached, we shall have traced up the rise of a social relationship.

A moment's reflection will show that it is neither to the nutritive functions nor to the reproductive functions[1] that we may look for the initial acceleration of habitual attitudes by interaction. The creatures being of the species and having the same needs must inevitably to a greater or less extent fix upon the same objects for their gratification, whereby there springs up an interaction of opposition in the struggle for existence. Such a situation causes pain, the retarding of life process and the consequent contraction of the habitual attitudes, so far as any interaction may enter in.[2] While there also springs up a certain interaction of opposition in habitual defense attitudes (seen in the flight of a herd of deer, where the individual is more or less encumbered with the presence of his fellows), yet it is not nearly to the same degree as in nutrition. For the most part, as we shall see, habitual defense attitudes occasion an interaction of coöperation, which accelerates the life-processes. We shall therefore, without further preliminary, show how the impulse of self-conservation along the lines of habitual attitudes of defense becomes modified to include the similar habitual defense attitudes of the other members of the species. In showing how creatures thus become partakers in defense we shall also be tracing up the rise of social relationship.

[1] The reproductive functions are very slightly susceptible to interaction, either of collision or of coöperation (an example of such coöperation along this line is nest-building), so they may for the present purpose fall out of consideration.

[2] The fact that burying beetles (G. J. Romanes, 'Animal Intelligence,' 1883, p. 226) display active coöperation in securing food, should have no weight against the general rule that nutritive functions are not the first to start coöperation. For it is a rare case. Few instances at this period are known of coöperation for food, while cases of coöperation for defense are normal. Then it is not recorded that burying beetles *regularly* combine to secure food, but only where combined effort is absolutely necessary to secure the food *at all*. Looked at in this light, the coöperation of burying beetles might even be considered a case of coöperation for *defense*. From this fact it is readily inferred that interaction of opposition at this early stage, so far from tending toward a consciousness of kind, by accelerating life-process and producing a social relationship, tends rather against it, by retarding life-process and preventing a social relationship.

'Social' Organic Imitation.

As the starting point in this investigation of the social relationship we fix upon the phenomenon of organic imitation (circular reaction),[1] or, more strictly, a particular phase of organic imitation. This fact of the organic life has been chosen because it is through such organic imitation, as we shall see, that the defense attitudes of creatures come into an interaction of coöperation, which is the social relationship.

As a characterization of the phenomenon in question,[2] suppose two primitive creatures A and B of the same species are living in propinquity. Suppose that B under certain circumstances invariably emits certain sounds, goes through certain movements, or the like. A, being of the same species, emits, under the same circumstances, similar sounds, goes through similar movements, etc. Now if A at any particular time becomes aware of certain sounds and movements of B, indicating flight, the very awareness reinstates *A's* own motor processes, which tend to discharge, and that in the same way as *B's* are discharging.[3] In A, we have an example of the phase of organic imitation which concerns the present problem. We observe that it is a process of duplication in a creature of motor processes and movements, through what may be called sensori-motor suggestion.[4] This is the important and differentiating factor about the phenomenon, that it is a sensori-motor suggestion *from the creature's own species.*

If the anticipation be permitted, we may distinguish this particular phase of organic imitation by the term *social* organic imitation. When referred to a period in life history, 'social' organic imitation is probably first observable with the echino-

[1] *Vide* 'B's Dict. of Philos.,' art. 'Imitation.'

[2] Following J. Mark Baldwin, 'Social and Ethical Interpretations,' 1897, Appendix D, 'The Genesis of Sociality.'

[3] J. Mark Baldwin, 'Mental Development in the Child and the Race,' p. 133: "The stimulus starts a motor process, which tends to reproduce the stimulus, and through it, the motor process again." Since in the phase of organic imitation under consideration the stimulus comes from another organism, we may differentiate further, still quoting from Professor Baldwin (p. 334): "The motor attitude seen, we may say, is itself the copy, which tends to bring about its own duplication in the person seeing it."

[4] *Vide* J. Mark Baldwin, 'Mental Development,' ch. 6, sec. 3.

derms. Romanes observes that howbeit the echinoderms are unable to profit by individual experience and exhibit no truly mental phenomena, yet 'reflex action in these organisms is full of interest.'[1]

Rise of the Social Relationship.

Having now characterized the phenomenon of organic imitation, we pass on to consider how it brings to pass a bond between creatures, or the earliest social relationship. We suppose, in the first place, that *A*, *B*, *C*, etc., of the same species, are each in danger of falling a prey to *X*. The perception of *X* reinstates an attitude of flight (we will say), which is accompanied, on the one hand, by an emotion of fear, expressed possibly in sounds of some sort; and, on the other hand, by a thought-content, which at this stage is a consciousness of movement (when the motor process actually issues in movement), plus a perception of *X*. When an operation such as we are describing becomes racial, the creature's motor attitude is in a state of unstable equilibrium. Ready to discharge at the slightest stimulation, it expresses itself in certain gross movements of attention to anything and everything, suggesting the presence or proximity of *X*. The entire psychosis may be styled the ***habitual attitude*** in time of danger.

As we have already noticed, a chief suggestion of *X* comes through sounds, etc., from the others of the species. In any particular instance, when *B* upon awareness of *X* has reinstated his motor processes of flight, *A*, etc., through the function of 'social' organic imitation also reinstate the same motor processes, and are thus saved from falling a prey to *X*. The *A's* who have been saved by thus reacting organically upon awareness of *B's* movements and sounds, will tend to repeat the reaction as often as the situation arises. The reaction, if it continues to prove advantageous, leads to an actual variation in the species' habitual attitude toward danger.[2] The reaction

[1] G. J. Romanes, 'Animal Intelligence,' p. 23; also diagram in Romanes's 'Mental Evolution in Animals,' pp. 76, 348.

[2] K. Groos ('The Play of Animals,' 1898, p. 78) writes: 'The imitative impulse is directly useful in the serious work among most, presumably all, higher gregarious animals'; and Alex. Bain ('Mental and Moral Science,' 1872, p. 336): "The character of gregariousness follows the imitative power.

will develop the emotional expressions of the motor processes involved, and at the same time it will also sharpen the creature's susceptibility to these expressions. In the course of evolution, the thought of danger will come to contain attention-strains directed not merely upon X, but also upon the signs of X which are the sounds and movement of his fellows; and the creature will respond to and reinstate the motor processes of defense quite as readily at the suggestion of the one as of the other. The aspect of the creature's habitual defense-attitude, which is thus directed primarily toward the other creatures of his species, constitutes the most primitive social relationship. We call it a social relationship, because first of all the creatures partake of one another's experience of X in so far as their habitual attitudes toward danger, count upon sounds, etc., of one another, indicating that danger. It is a social relationship because the creature's impulse of self-conservation along this particular line has been so far modified as to make use of or include the impulse of every other creature of the species when stimulated along the same line.

This account of a social relationship would seem also to fulfill Mr. J. S. Mackenzie's notion of society (despite his injunction that animal society is 'nothing but an aggregate,' *lib. cit.*, p. 160), to the extent that it is 'a system in which the parts have a certain relative independence, but an independence which is conditioned throughout by its relation to the system — an independence, in short, which is not freedom from the system, but freedom *in* and *through* it.'[1] On the other hand, there is at present no evidence of 'an inner development toward an end';[2] for such an 'inner development' becomes possible only when the consciousness of kind has emerged and thus brings the social relationship to the consciousness of the creature. In the example B did not make the cries for the purpose of warning the A's; nor are the A's conscious of B in any other way

There could be no community of action without this aptitude." On p. 35 f we mention more fully the fact that so far as mutual aid proves advantageous, the preëxisting instincts of defense will tend to break down or merge into it. This means simply that the creatures are more likely to survive that are adapted to this 'social' way of defense.

[1] 'An Introduction to Social Philosophy,' 1890, p. 130.

[2] Mackenzie, *lib. cit.*, p. 160 n.

than as the source of certain movements of flight, etc., the very awareness of which reinstates similar movements. At present the creature has no other 'end' in coöperation but his own preservation, so that the social relation is expressed thoroughly in terms of the individual's impulse of self-conservation.

In view of the above statement it becomes clear that in speaking of a social relationship at this period we do not mean a psychologico-social relationship, but rather a biologico-social relationship; that is to say, the social *organism* is present and the parts thereof act as the parts of a human social organism act, yet the consciousness of the creature evidently does not represent to itself a social end or aim. Considering that in the instance cited we have an example of the earliest social phenomenon, it is plain that the phenomenon subsists simply and solely in a reaction. The social relationship at this its inception *is* the 'social' organic imitation seen objectively; and on the other hand, every expression of such organic imitation is at one and the same time an instance of the earliest social phenomenon.[1]

The fact that we have explained the rise of a social relationship so exclusively from the 'social' organic imitations with habitual attitudes of defense, does not imply that such organic imitations are necessarily confined to defense, for 'social' organic imitation operates wherever the motor attitudes express themselves emotionally. It rather implies that the defense attitudes are, as a matter of fact, the first to express themselves emotionally. This should be clear from all that has gone before.[2] The exercise of the nutritive function produces interaction of collision among creatures of a kind. The interaction of collision causes pain and the consequent contraction of the characteristic habitual attitudes. By this is not meant the literal inhibition of the nutritive function, which would be manifestly absurd, but such a variation as will preclude the inter-

[1] If objections are raised against the term organic imitation, the confusion may seem increased by the addition of 'social.' By 'social' organic imitation we mean what some writers call 'organic sympathy' (which is to us confusion); and the term 'social' organic sympathy is justified precisely in this present discussion because of its aptness in indicating the social evolution, especially in the way it sets off the social conscious imitation, which is imitation proper.

[2] *Vide* p. 24.

action of collision. We observe that the most obvious variation will be at endency toward inhibition of the emotional expression, springing out of nutrition. A creature exercising the nutritive function in the vicinity of his fellows will so far tend to inhibit the feeling reaction in such a way that his fellows do not become aware of his good fortune and deprive him of his spoil. In a word, he takes his food apart.

From the above conclusion we are able to observe more particularly than on p. 24, why it has been necessary to explain the rise of a social relationship so exclusively from the 'social' organic imitation with habitual attitudes of defense. The emotional expression, which is at once the hinge of 'social' organic imitation and the underlying condition of a social relationship, tends to be inhibited in the exercise of the nutritive functions. The emotional expressions connected with defense attitudes, so far from being inhibited, fall directly in line with the impulse of self-conservation, and are expanded to the utmost. The creature, so far from experiencing any disadvantage from giving vent to his feeling of fear, rather experiences its great utility in self-preservation, so that such expressions will survive. In short, while all other emotional expressions are left comparatively weak, the emotional expressions connected with defense attitudes will continue to expand, forge ahead, and come to have definite and habitual forms through which 'social' organic imitation functions. We conclude, therefore, that social relationship is virtually dependent for its rise upon 'social' organic imitation, operating in defense attitudes. A social relationship, subsisting in motor attitudes of nutrition and of reproduction, we consider, will be a result of the basal social relationship, subsisting in defense attitudes.[1]

Summing up our results, we reach this conclusion: The first link in the causal chain which leads to the possibility of the

[1] As on page 24, so also here and throughout the essay we build upon the normal threefold order of function in creatures, viz., nutrition, reproduction and defense. Exactly how the social relationship would arise in a species where no defense is needed, is not for this discussion to say. It would obviously have to work out its salvation somehow through the avenues of nutrition, with its collisions and compromises; or possibly, it might arise first along the lines of conjugal tenderness and filial affection.

consciousness of kind is that state of consciousness which involves in 'social' organic imitation with habitual defense attitude, the rise of a social relationship, or such a social relationship, as has been explained above. The starting point in the further investigation of these causes will be this same rudimentary and quasi-social or 'social' organic consciousness, manifested in every expression of the 'organic' social relationship. As the initial step in this investigation, up to the point where consciousness of kind arises, we shall define more closely the primitive social relationship. This will determine what phase of social relationship has the possibility of the social evolution, yielding the consciousness of kind.

CHAPTER III.

THE EVOLUTION OF THE SOCIAL RELATIONSHIP.

The Two Types of Social Relationship.

A social relationship springs out of 'social' organic imitation with habitual attitudes of defense, corresponding to feelings of fear and of anger.[1] We shall first make plain the habitual attitudes, with their corresponding phases of social relationship; then, by a comparison, determine which tends to the larger and more adequate growth in social consciousness.

The first of these attitudes has already been spoken of. The preponderating feeling toward the environment is fear; and the corresponding and habitual attitude is flight at the approach of danger. The species survived at the first by 'social' organic imitation with certain movements of flight and emotional expressions of fear on the part of its members indicating the presence of a hostile force. And it continued to survive by having incorporated within the habitual attitude those particular processes of attention that lead to this very 'social' organic imitation. Thereby the 'social' organic imitation becomes fixed or racial, and the members of the species in whom the 'social' organic imitation has become an expression of an habitual attitude in the face of danger, will form a 'company.'[2]

The second attitude is that of resistance, associated with the feeling of anger. This attitude is not so clearly manifested at the earliest period of social consciousness as the flight-attitude is. Anger denotes aggression, initiative, which signifies a more advanced stage of mental evolution. There is, however, some disposition to resist (growing out of anger) as low as the mol-

[1] "These emotions are said to be instinctive or organic. They seem to belong to the physical organism and to be so closely knit into the structure of the body by its heredity that they serve to protect us from harm and to secure benefits without assistance from our reflective processes." (J. Mark Baldwin, 'Social and Ethical Interpretations,' p. 187.)

[2] *Vide* Appendix.

lusca,[1] and this justifies us, so far as the present problem goes, in placing the second attitude upon the same general level of consciousness as the first. We shall show its workings by reverting to a general example, using the signs A and B. Suppose the creatures A and B upon a level of consciousness corresponding to that in the previous instance, yet actuated in this case by a primitive feeling of anger, with a corresponding inclination to *resist*. We will say that under the present circumstances A (as well as B) has in times past resisted more or less successfully some creature-X that encroaches upon him. If then at any particular time X appears against B in the vicinity of A, we have, it is clear, an expression of 'social' organic imitation on the part of A. Just as in the former case, A*'s* perception of B*'s* movements, etc., indicating resistance, tend in that very perception to reinstate A*'s* own movements, etc., of resistance, with the result that A also resists (or tends to resist) along with B.

A social relationship may rise out of habitual attitudes of resistance in precisely the same way as we have shown it to arise out of habitual attitudes of flight.[2] The creatures of the species survived at the first by their movement of resistance in common, and the species survives in the form of a company by a 'social' organic imitation on the part of its members with the habitual attitudes of resistance.

As the social relationship forms, we can picture how it has happened that creatures have come to involve or implicate each other in the attentions to danger, and then, when the dangerous thing actually appears, to include each other also in defense. The thought-content of A, in habitual defense by resistance, will come to have two thoughts of B. (1) In the thought ex-

[1] *Vide* Prince Kropotkin, 'Mutual Aid among Animals,' *Nineteenth Century*, 1890, p. 343. The disposition to resist is strong in spiders, placed by Romanes ('Animal Intelligence,' p. 205) just below the fishes; but they live so solitary a life as to be otherwise not a good illustration.

[2] *Vide* Appendix. We have found actual animal companies in which fear constitutionally predominates. We hardly find an actual animal company in which anger constitutionally predominates. The reason for this is that fear arose first, and remains now along with anger, so that a species which has grown to resist from anger in one direction, may still remain in habitual attitude of flight from fear in another direction.

pressed as movements of attention to danger, there is contained the awareness of *B*, suggesting the danger from *X*. (2) In the thought expressed as movements of defense, there is also contained the awareness of *B*, assisting in resisting *X*.[1]

Finally, lest we fall into psychological error, we must bear in mind that since *A* is aware of *B* (and *vice versa*) in no other way than as merely the source of movements, etc., indicating resistance, and since his assistance results organically from the simple awareness of *B's* movements, etc., there can be no consciousness on *A's* part of a social relationship. This must be the inference so long as we consider social consciousness in its first period expressed as 'social' organic imitation.

With this statement of the two attitudes and their respective phases of social relationship, we pass on to consider their respective values in the growth of social consciousness. The two phases of social relationship are alike in the matter of their origin. Each springs out of 'social' organic imitation with habitual attitudes of defense. But with this one fact in common the resemblance ceases; they are precisely as little alike in operation as their emotional expressions, fear and anger. In the phase of social relationship subsisting in fear and habitual flight, we observe that the interaction of coöperation is found only in the habitual attitude toward the *danger*. When the danger materializes and as soon as ever the habitual defense attitude is reinstated and issues in movements, the members of the company are straightway thrown back upon their own individual resources; each individual shifts for himself and the social relationship with its very inception ceases to exist. On the contrary, the social relationship springing out of anger only reaches its climax after the signal has been given and the reaction has actually set in. By the same inherent law of nature which compels creatures surviving by flight to separate, the habitual resistance-attitude compels creatures to unite. Not

[1] It is difficult to avoid speaking, at this stage, of *A's* attitude as that of intelligence, and of the variation as due to 'functional' selection or even conscious choice. For the reason that intelligence, even if it does operate at this stage, is not *social* intelligence, we prefer to hold off incorporating the intelligent or as we call it the 'representative' factor until the first stage of 'social' evolution is reached.

only does A become keenly and habitually perceptive of sounds and movements by B, signifying the presence of a hostile force, but also and by the same process B (standing for any creature directly attacked) 'counts' upon A's reinstatement of the same positive defense-attitude. They resist together, and as long as the hostile force continues each looks for the other's presence and aid. Thus from the start to the finish of this positive defense-attitude there functions a social relationship.

The question as to which of these two phases of social relationship yields an adequate growth in social consciousness has now been all but answered in the very comparison of the two phases. The social consciousness of the creature of fear and flight has not such possibilities for the growth of social consciousness as has the social consciousness of the creature of anger and resistance. True, the creature, as we explained, tends to improve the variation in defense, which may bring the eyes and ears of other creatures between him and the hostile force. But even such modification of the original defense-attitude is incidental to the defense-attitude as a whole, which, consisting in flight, continues to remain (as in the presocial state) unchanged. As already shown, the creatures surviving by flight do not reckon so completely upon one another. Their safety lies in the keen eyes and nose or the long legs; it is along these lines that variations in defense tend principally to appear, and such variations, it is clear, do not necessarily include the other members of the company, but are individual-regarding. Therefore we may conclude that, beyond the point already noticed, the flight-attitude will tend to exclude as essential positive factors to the individual's well-being the other members of the species.

The habitual attitude of resistance, on the contrary, in its very nature demands a coöperation involving the entire defense-attitude of the creatures. Just as surely as each creature counts upon each other creature to apprize him of the hostile force, just so surely, when the warning of attack is given, does each creature also count upon each other creature to resist with him. If we assume that that coöperation, involving the creature's entire impulse of self-conservation along the line of defense, is the

social relationship which makes for the largest possible growth of social consciousness, then it is plain that we are concerned with that phase of social relationship which subsists in the attitude of combined resistance. Under the rubrics of this phase of social relationship we shall look for the consciousness of kind.

We have stated these phases in social relationship so antithetically in order to bring out clearly and simply the respective values of the two attitudes. As already noted, the phase of social relationship subsisting in attitudes of resistance is naturally found in actual life along with the attitude of flight. Indeed, if we were to take a cross-section of those forms of social consciousness to which we should naturally look for instances of the consciousness of kind, we should find a striking mixture of fear and anger, flight and resistance. All we may say with certainty is that, since it is the 'anger and resistance' element out of which we expect consciousness of kind to spring, this element so far preponderates in the general conscious content.

The Mutual Aid Instinct.

Proceeding now to the evolution of the social consciousness, we recall the meaning of this discussion of primitive social relationship, and its tendencies in social consciousness. The fact that sympathy arises at all, means that consciousness must become socially representative to the extent that creatures in their representations, recognitions and reflections will become conscious of other creatures as being of the same kind. The social consciousness has emerged, and though rudimentary, and so far as yet disclosed organic, shows, nevertheless, distinct tendencies. The discussion of these tendencies has served to indicate along what line we may expect consciousness to evolve, in order to become more thoroughly social and socially representative. Social consciousness is now fixed at a period in its evolution when, through the expression of 'social' organic imitation in attitudes of resistance to a hostile force, there tends to arise a certain mutual aid among creatures.

From what has gone before it is plain that this tendency to mutual aid, capricious as it is at first, has in time a decided in-

fluence upon the defense attitudes of the species. The instincts of the defense, operating hitherto, become modified to include or reckon with this new preservative factor. As Professor Baldwin has expressed it,[1] "Each instinct is shaped to fit into the same instinct in other individuals. This is what coöperation means." This aspect of the habitual defense attitude we shall now term the instinct of mutual aid,[2] by which we understand: (1) on the cognitive side of the habitual defense attitude, an instinctive susceptibility on the part of the individual to certain sounds and movements of his species, signifying danger; (2) on the motor side, a corresponding instinctive readiness to reinstate certain motor processes of defense in such a way as to involve the aid of the species. At this stage of mental evolution the instinct of mutual aid is the whole of the social consciousness, and constitutes in its operation the social relationship in its entirety. Strictly speaking, it is the phenomenon of 'social' organic imitation, functioning according to the means of defense already at the creature's command; yet, just because these means reckon with the other creatures of the species, the mutual aid instinct has the utmost importance for the problem in hand.

It is clear that with the genesis of the social defense attitudes of the mutual aid instinct the relationship between creatures becomes a well-defined fact of the life together.[3] The mutual aid instinct, thus started in connection with habitual defense attitudes, tends to extend itself to all forms of activity. A species that displays aid in defense, tends also to aid in nutrition, and also, so far as possible, in reproduction. But such extensions of mutual aid are, at this period of 'instinct' sociality, rather sporadic. We have already pointed out that interaction in nu-

[1] 'Social and Ethical Interpretations,' p. 281.

[2] There is an instinct, the parental, which may be said to have a marked influence in strengthening the mutual aid instinct. Thus a creature which assumes the attitude of resistance in behalf of its eggs (we find instances of this upon the level of the fishes, *vide* A. Sutherland, *lib. cit.*, Vol. I., pp. 34, 36, 38) will tend more easily and naturally to assume that attitude in behalf of the species generally.

[3] For many instances of active coöperation see especially Prince Kropotkin (*lib. cit.*). It must be held in mind, however, that very many of these instances display a level of social intelligence which we have not yet reached in the evolution series.

trition is an interaction of opposition; it tends to retard life processes, emphasizes the primordial individualism of creatures, and prevents any social relationship. The interaction in defense, which is an interaction of coöperation, expands life process, produces the social relationship and tends to counteract the interaction of opposition as we have just noticed; yet even under the mitigating influence of common defense we find but few, if indeed any, instincts of coöperation for nutritive purposes.[1]

Let it be said, furthermore, that as nutrition is the chief end of the creature's life, so aggression is and remains the most palpable fact in the animal world. 'The collision of agencies'[2] does indeed lead to coöperation, but only after a mutual toleration between the wills concerned, 'an equilibrium of toleration,'[3] when the creature recognizes, so to speak, that 'half a loaf is better than no bread.'[4] But such recognition involves at once a clear consciousness of ulterior ends and a high order of self-control, which we can hardly accord to the comparatively early orders of consciousness here under investigation. Professor Baldwin[5] seems to take this view of the situation, where he sets animal activity as 'violent, straight away,' over against human activity as 'docile, deliberative, plastic.'

Before proceeding with the evolution of the social consciousness up to the point where the consciousness of kind arises, and in order to the correct understanding of this evolution, it is necessary now to explain and incorporate two factors which are absolutely essential to the consciousness of kind and sympathy. These are: (1) The representative consciousness, which we have already mentioned, and shall explain on p. 40 ff.

[1] The nest building of the land crab (*vide* Kropotkin, *lib. cit.*, p. 343) is an example of coöperation for reproductive purposes. Among fish the shark, the dogfish, and the carp practice coöperation for nutritive purposes (*vide* P. Topinard, *lib. cit.*, p. 222). It is not noticed that they divide the spoils: when it comes to the actual feast it is 'might makes right' (*vide* Bullen, 'The Cruise of the Cachelot,' p. 109).

[2] *Vide* A. T. Ormond, *lib. cit.*, pp. 194-5.

[3] F. H. Giddings, *lib. cit.*, pp. 113.

[4] Professor Giddings ('Prin. of Soc.,' pp. 109-10) believes that conflict is always strong, and imitation even tends only to mitigate it.

[5] 'Social and Ethical Interpretations,' p. 303.

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(2) The consciousness of self. The same conditions that evolve social consciousness, evolve at the same time the whole mental equipment of the race. In the previous discussion it has been difficult to speak without involving especially these two factors. The reason their treatment has been held off arises from the necessity of holding clearly before us the *social* consciousness. So far as intelligence and self-consciousness have been existent at all up to this period, they have been non-social or antisocial. The investigation in general needs the representative consciousness and the consciousness of self only in so far as they are socially constituted, and the ensuing discussion deals with them solely with a view to a *social* self-consciousness and the consciousness of kind. In the process of evolution they overlap; yet in view of the fact that the creature has a certain consciousness of self before the representative consciousness has emerged, we shall explain the consciousness of self first.

Rise of the Sense of Self.

We assume to start with, that the lower animals may have a consciousness of self. "In one sense," writes Mr. Mackenzie,[1] "there is every reason to believe that the animals are as much conscious of a self as we are, or at least that the consciousness of self is present in them, relatively to the general distinctiveness of their consciousness of things, as it is in us." There is a sense in which self-consciousness is coeval with consciousness itself. Hegel speaks of the primitive self, which he calls the sentient self, as a bundle of habits, and of self-consciousness as immediate feeling, or the bodily feeling, accompanying habits. Later researches have emphasized the essential motor nature of these habits, or instincts, strictly speaking.

The first sign of consciousness is found, according to Professor Bain, in *spontaneous* movement, by which he means movement as reaction upon organic stimulation, or 'simple contractility' (Baldwin). Such reaction is the original 'Wille zum Leben,' the first symptom of self-conservation in anything that has become conscious. The notion of the self is grounded in this

[1] *Lib. cit.*, pp. 160–1.

conception of vital activity,[1] and when the reactions upon the external world become determined and then differentiated into more or less definite or adaptive motor processes of expansion and contraction, we have arrived at a notion of the primitive self. The consciousness of this 'self' is simply the consciousness of the active and conative disposition.[2] This is 'the bare presentation of the self' (Ward), but it is plainly not yet a true consciousness of self. "As sentient the soul is no longer a mere natural but an inward individuality, yet being immediate it is not yet as itself, it is not yet a true subject, reflected into itself."[3] The creature is indeed concious; but the consciousness of the *self-identity* is a matter wholly in the mind of the observer.[4] We might say with Mr. Mackenzie[5] that the consciousness of the identity is *implicit* in the creature's consciousness of pleasure and pain.[6] It is not until consciousness has advanced to a period where along with the sensory process there is also a perception of the stimulating impression and along with the motor process there is also a perception of the movement, as giving pleasure or pain, that we approach true self-consciousness.

Perception is a distinctively psychological notion, and marks the beginning both of true self-consciousness and of representative consciousness. We will suppose that the creature has a perception of all other bodies and also of his own body. Now as the creature begins to perceive and remember bodies he re-

[1] 'The earliest and to the last the most important element of self is that variously styled the organic sensations, vital sense, conæsthesis or somatic consciousness,' James Ward, 'Encyl. Britannica,' art. 'Psychology,' p. 83. Professor Wm. James speaks of the feeling of bodily activity as the nuclear self, the self of selves ('Prin. of Psychol.,' 1890, Vol. I., p. 301.)

[2] Dr. Bradley (Appearance and Reality,' 1893, p. 80) speaks of the kinæsthetic feelings as 'the inner core of feeling,' which is the basis of the sense of self.

[3] Hegel, 'Philosophy of Mind' (tr. Wm. Wallace), pp. 27, 28.

[4] *Vide* A. T. Ormond; *lib. cit.*, p. 257.

[5] *Lib. cit.*, p. 164 n.

[6] The 'implicit' consciousness of self may be placed at a stage of mental evolution corresponding roughly to the period of the echinodermata. We consider also that this 'affective period' of selfhood arises rather earlier than the period in which 'social' organic imitation functions and a social relationship arises.

'kind' means 'species,' and a resemblance between individuals neither more nor less thoroughgoing and essential than the resemblance which goes with being of the same species. The actual task of investigation takes, as its starting point, the period of organic resemblance among creatures, but since the creatures are of the same species, the resemblance is a matter of the entire creature; and we find ourselves actually starting with the period of organic consciousness pure and simple.

members this one body as unique among bodies. First, it is always present, the center of position and the type of occupied space. Second, this one body, now that the *perception* of its movements is bound up with the feeling accompanying movement, is also perceived as a feeling-body.[1] Thus while the creature perceives other bodies, it both perceives and *feels* its own.[2] We may say that it is this inwardness (Ward) about feeling which is the first sign of true self-consciousness.

The next stage in the evolution of self-consciousness involves some treatment of voluntary attention, for self-consciousness is properly speaking a function thereof. Inasmuch, however, as voluntary attention is also a process of intelligence, we shall pass at this point of contact over to the discussion of intelligence, or, as we have termed it, the representative consciousness.

The Rise of the Representative Consciousness.

The rise of representative consciousness is fixed at the point when presentation becoming complex demands a correspondingly complex coördination in order to a successful adaptation. We take as the index of the representative consciousness the *recognition* of an object. In order to recognition two things are necessary. Recognition we observe could not arise so long as the creature's environment was stable. Stimulation would be revived regularly and reacted upon in a uniform manner. Recognition becomes possible when there is a variation off the normal. But change in the environment cannot of itself produce recognition. Changes have been occurring and recurring constantly without the creature's necessarily distinguishing them; and then when these changes have become sudden and catastrophic the frail lives have been swept away. The cause of recognition is a brain which is complex enough to support multiplicity of presentation and effect a corresponding complex coördination of muscular movements. This involves habit, acquired by the individual; and the habit in turn presupposes at

[1] The analogy with child development is clear in this observation by Professor Preyer ('Mental Development in the Child,' p. 146): "A child does not easily recognize its own body from foreign bodies. Merely seeing its own arms does not serve to distinguish its own from others. It does, after it has recognized certain movements of it as giving feeling — especially pain."

[2] Wm. James, *lib. cit.*, Vol. I., p. 334.

birth an unstable nervous system with hereditary impulses in the place of ready-to-use instincts. Thus the period of infancy in its broadest significance — the period of development from utter helplessness to self-help — is inevitable as soon as we take up the discussion of intelligence. Without at this point any further remarks upon the character of infancy, we shall take the creature within the period of his development and as low in the scale of mental evolution as possible. Within these bounds we shall indicate the rise of recognition, intelligence — in a word, what we call the representative consciousness, in distinction from the presentative. Speaking psychologically, this period in development to which we must here confine ourselves is the transition from the 'projective' to the 'subjective' stage, where the creature, after reacting upon objects without reflection, begins to deliberate upon these objects.

Suppose that a certain stimulation, for which the creature has had a certain reaction ready, now changes and becomes a complex presentation. For example, the razor fish[1] when disturbed by the presence of salt over its burrow habitually comes to the surface. But once after beating a retreat in this direction he was forced to leave the water altogether by an inquiring naturalist. Here is the opportunity for a recognition. The next time the deadly presentation of the salt is introduced into consciousness there appears associated with it the representation of the last experience, *i. e.*, his being forced from the water. We say that the creature recognizes the changed situation, and we observe that recognition springs out of the very perception of this difference. Hence, in order to recognition the object must be not only revived but also pictured. It must be not only assimilated to the crass recept, but also seen in its individual relations, and assigned to its particular experience in the past.[2]

The recognition of the stimulation enables the creature to effect the necessary adjustment and make the required adapta-

[1] *Vide* Romanes, 'Animal Intelligence,' p. 26. This is not the best illustration for our present purpose, for it is not drawn from infancy in its narrower aspect. It is on the other hand a good illustration, for the period of infancy finds its rise at the level of the fishes (*vide* p. 72 n. 1).

[2] *Vide* J. Mark Baldwin, 'Mental Development in the Child and the Race,' p. 315.

tion. This means on the cognitive side the function of voluntary attention, and a deliberation upon alternatives. It means on the motor side that there is occurring a clash of reactions; the old refuses to accept and assimilate the new,[1] and the resultant is a coördination of processes which will stand for the necessary adjustment. It is not *absolutely* necessary to suppose an immediate picture of an end with its accompanying desire. The way of escape may have been spontaneous; the coördination may have been accidental. Nevertheless, the next time such a situation arises, we may be justified in supposing that the creature does picture an end. The attention becomes fixed upon an idea which *represents* the desired movement. The creature recognizes the presentation, remembers the movements necessary and makes them voluntarily for that end.[2] This we consider a sufficiently adequate statement of what we call the representative consciousness.

It is simply any consciously initiated variation upon an instinct or habit, especially such variation as demands a choice between alternatives.[3] The operation of the representative consciousness thus implied in making voluntary adjustments is observable as early as the mollusca. See, for example, Romanes's 'Mental Evolution in Animals' (pp. 20, 60), where the term 'mind' is used with the same meaning that we attach to the term representative consciousness. Professor Wundt also records a striking instance of such acquired adjustment in a spider.[4]

The growth of the sense of self involved in this experience should now be indicated briefly. We have said that the sense of self is a function of voluntary attention. Voluntary attention, we observe, begins to function when the creature, recognizing the desired movement, holds up and controls that coördination

[1] *Vide* J. Mark Baldwin, 'Mental Development in the Child and the Race,' p. 301.

[2] J. Mark Baldwin, 'Mental Development in the Child and in the Race,' pp. 428, 451.

[3] In the words of Professor Morgan, 'the creature begins to profit by its own experience.' For further elucidation of the influence of intelligence upon instinct *cf.* C. Lloyd Morgan, 'Animal Life and Intelligence,' pp. 452, 453.

[4] *Vide* W. Wundt, 'Lectures on Human and Animal Psychology,' 1894, Lecture 23, Sec. 4.

to the exclusion of any other. Now the sense of self is given in the first place in the recurring experience through the 'warmth' of recognition. Such feeling yields a consciousness of possession and ownership. Then the element of persistence in consciousness, due to this very strain and stress of the attention, yields again the sense of self; and it is especially this situation which constitutes a new thought of self.[1] Thus the creature's body becomes perceived as a center of space, as a feeling-body, and finally as a center of action and reaction upon other bodies, and these thoughts of this one body, relative and struggling as they are, keep gradually changing the creature from a consciousness of his body as *outer* percept to a consciousness of it as *inner* percept, all of which marks the first stage of self-consciousness. Such a change occurs very gradually. There is a constant dialectic between the inner and the outer, but the body perceived and remembered under many circumstances attains a certain degree of unity and permanence about which perceptions cluster and to which other bodies are referred.[2]

The rise of the representative consciousness has a most important bearing upon the social consciousness; for when we consider that creatures now have the power of representation, recognition and reflection, signifying the ability to change at will these habitual motor attitudes in which the social relationship subsists, then the social relationship might appear in danger of being disordered by the rise of the representative consciousness. This apparent difficulty is obviated when we take into consideration the nature of species.

Speaking broadly, it follows as a corollary from the fact that

[1] This has been called by Professor Baldwin ('Mental Development in the Child and the Race,' p. 337) 'the nascent sense of subject' over against the object. We agree with Professor Baldwin in making the determining cause of the developed sense of subject the imitation of a copy, set by a fellow creature. In discussing the rise of social self-consciousness we give this 'social conscious imitation' its full weight, *vide*, p. 55 ff. At the same time we believe that there can arise a 'nascent' self-consciousness by imitation of the creature's *own* copy image, and this is the antecedent presupposed in the above discussion. Such presocial conscious imitation is brought up more fully on pp. 52, 54 f.

[2] This account of primitive self-consciousness may be supplemented by reference to W. Wundt, *Physiologische Psychologie*, 2. Aufl., Bd. II., S. 217.

common traits of resemblance inhere in the very nature of species,[1] that representations will be common to the species. The individuals of a given species, invariably reacting to the same conditions in the same way, simply continue so to do when they as a species have grown to the degree of making voluntary adjustments. For example, both *A* and *B* make a consciously initiated variation in the mode of defense. This has taken place independently of each other, yet it is the same variation simply because they are the same kind of creature. Here for the first time we come on the representative resemblance, which is the fact immediately underlying the consciousness of kind.[2] But now if creatures of the same species, as soon as they represent at all, necessarily represent in broad outline the same things, then the social relationship will not after all be disordered by the rise of the representative consciousness. The habitual motor attitudes will change and adopt new forms of emotional expression, but the relative situation remains the same. The emotional expression of *A* will be recognized by *B;* and upon perception of sounds, movements, etc., by *A*, *B* will react, and that in the same way in which *A* is reacting.

The social relationship, it is just observed, has not necessarily been disordered by the rise of the representative consciousness. It is also very necessary as a precaution to point out that the rise of the representative consciousness does not, in and of itself, alter, or render less organic, the existing social consciousness. The fact that the creatures represent, and that these representations, common as they are to the different creatures, involve each other in defense attitudes — this fact cannot of itself even begin to occasion a social consciousness, which is self-conscious and psychological. The creature indeed acts as if he recognized that his social relations — his coöperations — are with creatures like himself; but the recognition does not take place in consciousness.

Furthermore, when we scrutinize consciousness at this period of mental evolution, we observe that it still shows that sharp distinction (howbeit not so bold or pronounced), which

[1] *Vide* p. 17.
[2] *Vide* p. 17.

was evident both in the presocial and the earliest social state, between the individual and his environment. To the consciousness of the creature, his fellows are still but part and parcel of his environment — mere circumstances, and recognized by him as such in the furtherance of his well-being. To the creature, his individual well-being is his supreme end. At first organic, this end now becomes conscious in specific desires. The benefit gained from active associations with his kind[1] is now brought to consciousness, and brought also, we must say, to the touchstone of individual well-being. When this end is not attained, as under any trying circumstances of defense,[2] the social relationship would be suppressed, and the individuals would shift for themselves, regardless of their fellows.[3]

This is a dark picture; it is overdrawn in order that it may make clear the individualism, working from the first, in and through the social relationship; but fortunately the same conditions which bring the creatures to represent, recognize, etc., will bring also the consciousness of kind into existence, and this factor in social evolution becomes the corrective upon reflective individualism.

It is plain that from now on the mutual aid is, broadly speaking, no longer an instinct. Professor Baldwin would term it an accommodation by functional selection.[4] There may be even an element of intelligent choice in its manifestations. Since, however, these sparks of intelligence are not as yet limited to the direct lines which lead to sympathy, we shall simply ignore them and retain the term 'instinct of mutual aid.' Thus used, the term will preserve its purely social connotation until the rise of the consciousness of kind is shown. At that point the instinct of mutual aid passes into a social intelligence.

These facts: (1) that consciousness is truly representative with a certain notion of self; (2) that representations are com-

[1] *Vide* p. 31 ff.

[2] *Vide* p. 87 f.

[3] An instance of the influence of representative consciousness upon coöperation for the individual's own interest has already been noted on p. 37, where the 'collision of agencies' in nutrition produces the 'equilibrium of toleration.'

[4] *Cf.* C. Lloyd Morgan, 'Animal Behaviour,' 1900; also 'B's Dict. of Philos.,' art. 'Selection.'

mon to the species, which is the representative resemblance immediately underlying the consciousness of kind; (3) that the creature has not yet brought his thinking to bear upon his attitude toward the creatures of his species to the extent of recognizing them as his kind — these facts we must bear in mind until the stage of mental evolution is reached which reveals the rise of the consciousness of kind.

CHAPTER IV.

Rise of the Conditions of Sympathy.

Consciousness of Kind, Foreshadowed in (a) the 'Real' Struggle for Existence.

Up to this point the discussion has dwelt in general terms upon the working of the mutual aid instinct. The mutual dependence of creatures in social relationship will be discussed in detail when the affective conditions to sympathy are investigated. It is now necessary to fix attention particularly upon that aspect of the mutual aid instinct which is chiefly instrumental in bringing about the consciousness of kind. From now on, or until otherwise stated, we shall confine the discussion to a stage of mental evolution corresponding to a period of life as far advanced and no farther advanced than the birds. Between the mollusca, the lower limit, and the birds, the upper limit, we are able to find the conditions, as we conceive them, to the rise of the consciousness of kind.

The consciousness of kind was defined [1] as a state of consciousness in which any creature recognizes another creature to be himself, as he at the moment pictures himself. There now subsists a representative resemblance between two fellow-creatures, *A* and *B*. *A* has a certain sense of self; but *A* has not, as we have all along borne in mind, the notion of *B* as a self. *A* indeed is susceptible to the active attitudes of *B*; but merely as an object, distinct from himself in point of space and time. In order that *A* may be conscious of *B*, not as such an object, but as an object resembling himself in the sense just defined, it is necessary that *B* become the object of *A's* deliberation in his own stead, and not as a mere means to *A's* safety and salvation.[2] We shall now proceed to determine the rise of such a situation. This will involve at once a psychological discussion of the conditions to such observation and also a delinea-

[1] *Vide* p. 15.
[2] *Vide* p. 19.

tion of the series of situations in the evolution of sociability, through which such observation is finally brought forth.

Through the gross movements of attention to the signs of danger which characterize the cognitive side of the mutual aid instinct, we have observed that the individual becomes habituated to observe the other creatures of his species, howbeit it is not these creatures considered as *selves* that he observes, but merely as sources of sounds, movements, etc., which may indicate danger to him.[1] Furthermore, whenever a particular movement of defense has set in, by the very fact that the social relationship subsists in resistance-attitudes and not in flight-attitudes, the creature is brought close to his fellows, and they continue near each other in pursuit of the same end as long as the danger is present. Through this propinquity in the expression of the mutual aid instinct the creature has constantly before him the movements, etc., of his fellows, just to the extent that they are involved with him in the coöperation; and thereby he is made to become acquainted with one great activity of the species as it functions in a creature of his kind. This much we may now venture for the rise of the consciousness of kind, while the creature is actively engaged in the struggle for existence. Howbeit the creature's thought is directed wholly toward his own welfare, yet the situation we are in search of is beginning to form. The creature is tending in the very 'social' organic imitation to watch his 'fellow' creatures, and the rise of the consciousness of kind is now foreshadowed.

[1] As already pointed out (*vide* p. 26 f) the very fact of consciousness becoming social at all signifies an increased sensitiveness of the individual to the creatures of his kind. This trait of the social consciousness is richly developed on the physiological side by the rise of warm-bloodedness. Here, through the generative energy of warm-blood, creatures become at once more highly emotional and at the same time more expressive. In particular, the vocal power becomes more coherent, so that the creature will express himself not only, as heretofore, by movements, but also much more adequately by sounds. As Dr. Bain ('The Emotions and the Will,' p. 113) writes: 'Probably the foremost place among the associated signs of feeling should be given to the voice.' The individual being made aware of other creatures of his species through the ear as well as through the eye, much is added to the probability of the consciousness of kind, in the reinstatement of the motor attitude. The creatures of his species will come to mean more to the individual, and their presence in the reinstatement of motor attitudes will stand out prominently in consciousness.

(*b*) *'Play' Struggle for Existence.*

So far we have been considering the chances for the consciousness of kind with the creature in 'the thick of the fight.' But there is also a life of relaxation. As M. Topinard has pointed out,[1] the struggle for existence is not so unmitigated as some extreme disciples of Darwin would have us believe. There are frequent lulls; the creature, especially after the appearance of acquired accommodation, is not always possessed of hunger, neither is he obliged constantly to fight for his life. These intervals of relaxation are of two kinds: The creature may pass into a state of *repose*, signifying relief from all struggle for existence, either real or playful. When we reflect that, until the consciousness of kind has reached maturity and established in itself a social relationship, it is only in a social relationship *under the rubrics of the mutual aid instinct* that creatures are kept in a situation where they can possibly observe one another;[2] then it follows that the form of relaxation called repose cannot, at the very first, yield anything toward a consciousness of kind. Repose thus far will mean a cessation of all *coördinated* activity; the creature, except for the tentative stirrings of tenderness, sinks into a state of blank indifference toward his fellows.

Relaxation may mean a modified struggle for existence, as for example, the activities of flocking or herding, of migration, and the like. It is during such periods, when the social instincts are, so to speak, working freely, that the situation most probably arises which leads to social conscious imitation and then, under the proper conditions, to consciousness of kind. Assuming for the present the above fact, it becomes necessary to define this state of nature from the psychological viewpoint. A study of the conditions involved at this period in the life of a flock or herd goes to show that the activity in such a state of comparative relaxation is most apt to take the form.of play. Hence, it is the phenomenon of play which the discussion must now fix its attention upon.

Play may spring up along any line of activity, but the play

[1] *Lib. cit.*, p. 221.

[2] *Vide* p. 19.

concerned in the present investigation is, of course, that which brings creatures into situations yielding the consciousness of kind. This is the sort of play in which creatures continue to sustain the same intimate relations to one another which they sustained in the serious business of life. Thus it will be in some sort the play of the mutual aid instinct along which we must work in order to discover the consciousness of kind. Furthermore, since defense is preëminently social and very much more social than nutrition, it is plain that the plays along the lines of mutual aid instinct in *defense* will be the first social activity, if not altogether the only social activity, to yield the consciousness of kind. Professor Groos[1] remarks concerning certain of Mr. Spencer's observations of the quick 'social' organic imitation shown among birds[2] that this may often be playful, and if so it is certainly an instance of early coöperation in the spirit of play.

Play may be of two kinds, according as the impulse operates in the creature as pastime or for the purpose of development. The same conditions which yielded a period of relaxation must also yield the first kind of play; for certainly relaxation tends to generate a superabundance of vigor, and this factor is a determining cause of play. This kind of play, when indulged in, is retrospective. It is the simple reproduction of the serious business of life, for the mere pleasure of gratifying the instincts involved therein.[3]

This form of play must deepen the social relationship. If the creature is 'inclined' to recognize his fellows as of his kind, when engaged in the real struggle for existence, how much more will he be so inclined when, being thus relaxed, free either from fear or anger, he exercises the coöperations merely for the sake of exercise. We are of the opinion that, so far as the creatures have up to this point arrived at any intelligence by individual accommodation, this 'retrospective' social

[1] *Lib. cit.*, p. 206.

[2] Herbert Spencer, 'Princ. of Psychology,' Vol. II., pp. 562–3.

[3] "Nothing is more common than for animals to take pleasure in practising whatever instinct they follow at other times for some real good." Darwin ('Descent of Man,' Vol. II., p. 60), quoted from K. Groos' 'Play of Animals,' p. 81.

play of adult animals would be in the line of evolution, leading to the consciousness of kind. Thus 'retrospective' play would operate in games quite as we shall show the 'prospective' play to work, and whatever will be found true under that head of the latter, might apply in kind, though not in comparable fullness, to the former.[1] We have said, however, that this sort of play operates as a pastime. Just because it is thus recreative, it is neither persistent nor is it so very frequent. Since, therefore, the investigation is not limited to this 'retrospective' play of adult animals for the full account of consciousness of kind, we shall turn at this juncture to the serious play which impels development in and with a view to the struggle for existence.

The phenomenon of play is a good deal more a feature of the developing period than it is of maturity. The child is *par excellence* the creature that plays, and as Professor Groos, in 'The Play of Animals,' has so conclusively shown, play is absolutely necessary to this development. It is not because the young likes to play. It must develop and it develops by playing. The play-impulse is, so to speak, the legacy left by instinct to habit. Thus play is a vastly different thing to the developing creature than to the creature already developed, and just because it is so normal to the former state, it is there that we should especially fix the attention in the present discussion.

Before passing on to the investigation of the main problem, there is still one thing which must detain us a moment. It may be thought that in investigating the play of a growing and learning individual we have passed from the gregarious to the domestic relationship. The transition is apparent, not real. The truth of the matter is that the evolution of the race and the development of the individual coincide at this point. It is strictly a point of contact and we are not really shifting the line of investigation. The concrete state of nature here involved is the flocking of birds or the herding of cattle, and this is essentially a gre-

[1] We consider that the chief difficulty in the way of a consciousness of kind from the above elements of consciousness is that the sense of self not developed through imitation of a fellow-creature will be so very rudimentary. Any discussion of the consciousness of kind along this line would have to be supplemented by a further discussion of social self-consciousness through the process of social conscious imitation, so called (*vide* p. 55 ff.).

garious relationship. The discussion treats of the *developing* creature, and this applies not only to a young but to any creature that is learning.

According now to the presupposition of the inquiry, we shall have first of all in 'play' defense attitudes, the same manifestations of sound, movement, etc., as in the mutual aid instinct when used as an instrument in the real struggle for existence. This stands for the 'social' organic imitation. Furthermore, while the defense-attitudes in the first sort of play were retrospective, we are now dealing with them as prospective. They are pointed toward *future* use and are being learned. This new element stands for a conscious imitation. But it is, as yet, non-social. The creature imitates upon the basis of its own previous attempts at accommodation. The ensuing discussion, let it be said, will signify a shifting of the intelligence from this non-social conscious imitation to the *social* conscious imitation, whereby conscious imitation is brought into line with the 'social' organic imitation in what may lead to the consciousness of kind.

Proceeding now to the investigation in question, we notice that right at the start the prospective play differentiates itself from the retrospective. Over against the latter the play of the developing creature is more violent and unmitigated. It is indeed no pastime, for his future life depends upon it. On this account ordinary prospective play does not help signally toward a consciousness of kind. As we say, the instinct of conservation may be as overpowering in play as in work, and this irrepressible activity of the play-impulse tends to narrow the opening for impressions of others, even as much as the real struggle for existence.[1] It is a refinement of early play that gives us the clue to the difficulty. This refinement arises when variations in play off the original mutual aid instinct begin to appear.[2]

As the play becomes complicated and games are formed, we find as one of the game's characteristics that it imposes

[1] *Vide* Alex. Bain, 'The Emotions and the Will,' pp. 115–16.

[2] Play, just because it is play, has such spontaneous variations off the original useful reactions, and reference to Professor Groos' investigation of imitative play will bear us out amply in this supposition. K. Gross' 'The Play of Animals,' ch. 3, sec. 3*b*, play with living mock prey; 4*b*, play fighting between adult animals; sec. 7, imitative play.

restraints upon the individual's play-impulse. That is to say, the play is no longer the organic reaction upon simple perception of another, but by the very exigencies of the play the tendency to reinstatement is held in check. This situation of voluntary *restraint* from actual movements of self-conservation, brief though it may be, is very pertinent to the present investigation; for while the creature is only *tending* to reinstate a motor process his field of attention is filled with sense-impression, which is the other creature in the play like him. In other words, the creature *A* is thrown into a situation, if only for an instant, where the attention terminates upon another creature *B*, and *B's* sounds and movements are more the object of deliberation to *A* than his own sounds and movements.

It is said that the above phenomenon of mutual observation in play is important to the investigation. It is not meant, however, that this concrete instance is the final situation in the series leading to the consciousness of kind. And the investigation will be illuminated if we tarry just long enough to explain why this phenomenon of observation contained in the restraint on play, cannot as yet yield the consciousness of kind.

In the first place the situation is that of play, and play having the individual's own well-being as its end-term cannot make the observation of its fellow sufficiently persistent and 'self-forgetful' for a thorough-going consciousness of kind. In the second place, and this is the more immediate reason, self-consciousness is yet too rudimentary for the recognition of self in another; so that even if there were given the opportunity for the necessary observation, it would profit the creature nothing. His selfhood has not been worked out in terms of the other creature. The one creature could not understand the other. He could not think of him as a self. And this is the reason, as was pointed out in the note on p. 51, why adult consciousness could hardly evolve a consciousness of kind. The situation of restraint upon play is important at this stage, not because it yields *of itself* a consciousness of kind, but because it yields what we call the 'social' conscious imitation. This social conscious imitation in the individual develops a social self-consciousness, which finally yields the consciousness of kind when the opportunity to observe his fellows arises.

Conscious Imitation and Social Conscious Imitation.

Conscious imitation has all along been understood to apply to a learning individual, such as is now under consideration. The copy for imitation is grounded in the thoughts of the former movements, which the individual is attempting to perpetuate and at the same time to improve upon. Thus the copy itself is the further thought of what the present movement is to be, in order to satisfy the demands of the present environment. In non-social conscious imitation the copy for imitation that tries to satisfy the new condition is the individual's own, and non-social becomes social conscious imitation when the attention is transferred from this ideal copy to the real copy presented in another creature. The transference could not take place if the two copies were unlike in kind.[1] The transference does take place because the copy image presented in another creature is so much more fit in point of clearness and distinctness to be the copy for the new adjustment. And this is the reason, it may be pointed out in passing, why the social conscious imitation survives and supplants the non-social. In social conscious imitation the individual has discovered a 'short cut' to accommodation, and this makes it the better instrument in the struggle for existence.

We will now take for our object of investigation a creature that has a certain inherited impulse toward intelligent adaptation and a certain sense of self, and who, under the influence of the mutual aid instinct in work and in play, is led to attend to movements made by the members of his species.[2] In this same heritage it may be said that social conscious imitation is also foreshadowed, for in the real struggle for existence, either real or playful, the creature will begin to detect differences, will begin to apprehend in his fellows the lines of new and better adjustments to his environment.[3] A favorable condition is fur-

[1] This signifies that, no matter how much two individuals are thrown together, social conscious imitation will not take place unless they are of a kind. Only in his kind does the individual find the copy he needs in order to secure the accommodation.

[2] *Vide* p. 47 ff.

[3] Professor Bain ('The Emotions and the Will,' p. 63) states broadly this fact when he says, 'next to grass, the proper study of sheep is sheep.'

nished here in the prominence given to certain normal types when used as sentinels.[1] These are the distinguished members most fit to be imitated, and they are placed in a position most favorable for imitation by the others of the kind. Thus the way is paved in the real struggle for existence for the interaction of consciousness in conscious imitation of one another.

We may picture the creature-*A* practising, as it were, a certain adaptation which is necessary for his self-preservation. We will suppose that the adaptation is only partly successful, for his copy is the memory of movements which were successful adjustments to a situation only partly like the present one. Reverting now to the former analysis we will further picture the creature-*A* at play, as already depicted, along the line of this half-learned adaptation. The play, so far as it is social, proceeds by 'social' organic imitation; but since it is the play of a learning creature, there is also, as pointed out on p. 54, the admixture of conscious imitation, as yet non-social. Now through the restraint upon the play impulse, under the 'social' organic imitation, 'the internal excitation alone is produced by the imitative impulse, whose reflex in consciousness consists of feelings of imitation.'[2] At the same time the field of voluntary attention becomes filled with the presentation of movements of his fellow creature-*B*. The attention of *A* becoming thus occupied with the sense impression of *B*, rather than with his own movement,[3] tends to influence this movement whenever a variation off the habitual action is suggested by *B*; and since the sense impression is the movements of a fellow creature, the suggestion makes the imitation, if it occurs, social.

We will once again suppose that at the 'restraint' stage in the play, where 'the æsthetic perception' is at its height, the other creature-*B* reacts successfully along the line which *A* has been attempting. What change now takes place in *A's* consciousness? In the first place, *A* comes to have two thoughts: (1) the memory of former trials-*A'*; (2) the image of *B* making the adaptation. Each of these thoughts tends to issue in movement,

[1] *Vide* Appendix.

[2] K. Groos, *lib. cit.*, p. 223.

[3] "All conspicuously imitative play must be preceded by that form of æsthetic perception which we have called inner imitation." K. Groos, *lib. cit.*, p. 224.

and since the one stands for an unsuccessful, the other for a successful adaptation, there is a conflict of the thoughts in *A's* consciousness. On the one hand the memory-thought of *A′* presses for reinstatement; and on the other hand the perception of *B* (according to the principle of the imitative impulse, illustrated on p. 25) tends also to issue in movement; and since the thought of *B* is not the thought of *A′*, the percept of *B* will tend to reinstate not the same processes as the thought of *A′*.

The fact that thought-*B* prevails (and this is supposition) means that thought-*A′*, while a thought of a habit, is the thought of a habit striving to accommodate itself to a new condition — the very condition, in fact, which *B* stands for, and which *A's* thought of *B* at this very moment is tending towards.[1] *A*, therefore, meets *B* halfway, 'greets' the thought of *B* with the thought of *A′*, and thus furnishes to himself the thought of *B*, as a copy for the desired adaptation. As Professor Baldwin terms the operation,[2] *A assimilates* the presentation-*B* to the memory copy *A′*, and this makes his imitation social.

That *A* now imitates *B* means that *A* for the time being loses sight of *A′* — the memory copy of himself, or of his former trials. Instead of the memory-consciousness of movements — former trials of adaptation — he is conscious only of *B*; and it is the presentation or memory-image of *B* that initiates the new trial after adaptation. So far as the thought-content is copy *B* we might say with Hegel that *A's* true self is for the time being in this other individuality — *B*, who becomes in very truth *A's* actuating subject. On the other hand, it is quite clear that, while *A* appears to himself to be reproducing *B* in making the adaptation, yet he is bound to reproduce not *B* but himself. To satisfy the conditions of his own self-consciousness he must make the adaptation in his own way; that is, upon the basis

[1] This uses the view of modern psychology that it is impossible for consciousness to make anything for itself 'out of whole cloth.' The elements of construction are themselves more or less familiar beforehand to the thought of the person who makes the invention. It is the line or way which the construction takes that is quite new (*vide* J. Mark Baldwin, 'Social and Ethical Interpretations,' Ch. III.)

[2] 'Mental Development in the Child and the Race,' p. 333.

of adjustments or habits already acquired.[1] Hence, while the copy-B has displaced for the moment the memory copy-A', yet so soon as the reaction is started again it is the thought of the new movement, which we might call A'', not the thought of B, which is attended to. Be the attempt at adaptation successful or not, the thought of his own movement will constantly tend to assert itself as the copy for imitation. Of course the partially successful accommodation continues to be corrected by the thought of B, and thought of B continues to be *re*-assimilated, as the copy for imitation, until the accommodation is finally acquired.

The fact that in learning the accommodation A returns so constantly to the thought of himself, yet also brings this self to a test of comparison with copy B, implies that A has now what may be characterized as an implicit consciousness of self in another creature.[2] In order that this consciousness may become explicit and become the consciousness of kind it is first necessary that A should have a clear consciousness of himself in the thought of the movements which make up the successful adaptation. Now if the thought of himself is the creature's first and uppermost thought in the consciousness of movement, whether successful or not, how much more keen will be the thought of himself when the accommodation is finally made, and he feels at once the thrill of successful accommodation and the warmth of ownership in this new muscular coördination. In the overpowering assertiveness of the self, which results from successful accommodation, the thought of the copy fades completely from con-

[1] If A were reproducing B as such, he would be acting in a way *absolutely* new to himself, which is contrary to the procedure of consciousness (*vide* note above). Compare also Professor James (*lib. cit.*, Vol. I., p. 318): "Each of us is animated by a direct feeling of regard for his own pure principle of individual existence."

[2] This statement appears to be at variance with Dr. Bain's view ('Emotions and the Will,' p. 203) that we first of all judge others by ourselves, not ourselves by others. While I follow Dr. Bain in this view, yet I believe it has reference to a matured social self-consciousness. Dr. Bain here is stating what Professor Baldwin terms the 'ejective' process of self-consciousness. This ejective stage we are just now in search of, for that it is which constitutes the explicit consciousness of another. At the present stage in self-consciousness the individual has no such consciousness of another, but only a consciousness of a copy-B, and a consciousness of an attempted adjustment-A'.

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sciousness. Dr. Bradley[1] speaks of this consciousness of successful activity as an expansion — a pleasurable expansion of the self within the self against the not-self. Notwithstanding the not-self is now grounded into the very warp and woof of the individual's nature, and in the explicit thought of himself, *A* is at the same time implicitly thinking of *B*.

At this point the creature has passed from the 'projective' stage to the 'subjective' stage of self-consciousness.[2] He has not, however, arrived at the full consciousness of self necessary to the consciousness of kind, because he has not yet begun to know himself explicitly in relation to another. This *recognition* (*die Anerkennung* of Hegel) of the copy as a self — an alter-ego — is necessary, we apprehend, to full consciousness of kind. The 'self-thought-situation' is given under conditions when *A* observes *B* (standing for any fellow creature) making the movements which he himself through this same copy-*B* was striving after and is able now to make successfully.

The 'self-thought-situation,' it appears at first sight, would arise of itself along the same line of observations as led to social conscious imitations, but a moment's reflection will remind us that this is putting a meaning into these observations which, considering the character of sociality at this period, is not justified. The previous discussion has been far afield if it has not borne in mind that these observations leading to social conscious imitation are made for the benefit of the individual, are in terms of himself, and terminate with himself.[3] As a direct consequence of this we had to detail in the psychological analysis that the copy image in the other creature fades from consciousness as soon as ever the creature effects the adjustment. Resulting from this attitude of the individual, the situation in the gregarious relationship, so far as it affects the consciousness of kind, will be plain. In the coöperations of work and in the ordinary exigencies of play, the creature remains at once so irrepressible in his activities and so occupied with the impressions of his own

[1] *Lib. cit.*, p. 96.

[2] For the present use of these terms *vide* J. Mark Baldwin, 'Mental Development in the Child and the Race,' p. 337 f., *vide* also note on p. 57 of the present work.

[3] *Vide* p. 54.

movements, that the impressions of other creatures as such will scarcely ever fill to the full the field of attention.[1] Finally, the observations of other creatures, occasioned by restraint upon play, potent as they are in yielding the consciousness of kind, are far too brief (just because they are part and parcel of the creature's play-impulse — itself an element of his struggle for existence) for a sufficient progress along this line, to justify us in assuming that the creature will have the opportunity for a consciousness of kind, in the sense defined. The creature has yet only a vague, nascent consciousness of himself in another creature. And we are forced to the conclusion that in the gregarious relationship taken alone, creatures will never rise above a certain point in their consciousness of kind.

The situation where the other creature is the object of thought in the way leading to social self-consciousness and consciousness of kind, should naturally be given in that form of relaxation which is called repose; but, as already pointed out,[2] repose, without social relationship, is quiescence and largely indifference; and repose, with the social relationship (*the* situation for the expression and growth of the consciousness of kind), presupposes the presence of the consciousness of kind in its explicit and thoroughly self-conscious form, which is the very thing we are now in search of.

In the domestic relationship we shall find a condition not found in the gregarious social relationship, where one creature is bound instinctively to attend to another over a protracted period of time. This situation, springing up under the conditions of the reproductive instinct, will bring the consciousness of kind to maturity. At the same time, however, that we give over the opportunity for the rise of the consciousness of kind to the domestic relationship, we must not lose sight of the steady growth, from this time on, of intelligence through social conscious imitation.

With social conscious imitation as the main instrument of

[1] Perhaps an exception to this individualism of creatures in coöperative activity is found in the sentinel (*vide* Appendix), yet it is a question whether this refinement of sociality emerges before the social relationship becomes conscious or representative.

[2] *Vide* p. 49.

adjustment, the social situation becomes the mould in which representations are most naturally formed. The more readily adaptations are made, so much the more will variation tends to appear, whereby there is given a great impulse to the intelligence of the creature. At the same time and in its very making, we find that representations becomes permeated with the qualities of those imitated, and the entire consciousness is shot through with social coloring. Thus we are able to observe how, through the very pervasiveness of the social conscious imitation, the way is well laid for the situation in which consciousness of kind may become explicit.

With this determination of the conditions immediately underlying the consciousness of kind, we shall now discuss, according to the outlines on p. 15, the affective factors in the social consciousness which underlies sympathy. These affective factors, which will be called *The Feeling of Attachment* and *Tenderness*, respectively, are not certainly sympathetic reaction itself. They are, nevertheless, indispensable to sympathy considered as a race product, and should therefore be investigated if an adequate understanding of the conscious-content underlying sympathy is to be reached.

The Feeling of Attachment.

Two specifications may be made at the outset with respect to this. (1) The feeling of attachment is, from first to last, a feeling grounded in the social relationship when the situation is that of activity, either real or sympathetic.[1] The feeling of attachment originates and evolves, just in so far as the individual is dependent for his welfare upon the social relationship in coöperations. Whenever the social relationship operates, either in play or in work, there functions the feeling of attachment; and when the social relationship, as thus considered, declines, there is a corresponding lapse of the feeling of attachment. Thus the mutual aid is 'the reason for being' of the feeling of attachment. (2) The feeling of attachment is both organic and representative. As the accompaniment of the

[1] After the consciousness of kind has grown strong and able, it may constitute a social relationship, even while the creature is in repose (*vide* p. 75); but the characteristic feeling of repose is then tenderness, not attachment.

mutual aid instinct it is organic. When the mutual aid instinct and the social consciousness become infused with a consciousness of kind, the feeling of attachment becomes just so far representative.

The organic feeling of attachment,[1] in its expression, is similar to the primitive, presocial feeling of inclination. It will be recalled that the feeling of inclination in its broadest signification was the feeling of pleasure toward creatures that were either useful to the individual in the struggle for existence or, while not useful, were not harmful; and, being constant quantities in the environment, are finally looked upon by the individual with positive pleasure. Considered from the standpoint of psychology, the organic feeling of attachment signifies that one creature perceives in another something that does not harm it, something that is necessary to its safety, possibly also to its securing food — something, in short, which is altogether necessary, in order to its well-being, to be with.[2] At this period the individual is attached to his fellows in the same way that he is attached to his food and shelter, for their usefulness to him. On the other hand, while this attachment, in view of its content, is of a piece with all other attachments, yet, in view of its end, it is different; and thus the feeling of attachment from the first differentiates itself from the presocial or quasi-social feeling of inclination. The feeling of attachment differentiates itself therefrom, because right at the first it is the feeling-tone of a social consciousness; then later, because it functions between creatures of the same species, who resemble each other representatively; and, finally, because its object becomes also the object of the consciousness of kind.

The organic feeling of attachment develops steadily in point of intensity and complexity as the mutual aid instinct develops; and when we reach the period when the consciousness of kind

[1] Dr. Sully ('Human Mind,' Vol. II., p. 103 ff.) calls this the *bare* feeling of attachment. "The child has this bare feeling of attachment for the mother, who gives it pleasure, which is generally mistaken for love in the child." Sully, however, seems not to distinguish between feeling of attachment and tenderness, as we do.

[2] Dr. Sully ('Human Mind,' Vol. II., p. 104). "The simplest manifestation of attachment is that of pleasure or satisfaction when with others, and a correlative pain or dissatisfaction when bereft of their society."

arises, the organic passes into what we shall call the representative feeling of attachment. Just as we cannot say for certain when the consciousness of kind arises, so we cannot say when the feeling of attachment becomes representative. The two affective states, especially now as we enter the play period, overlap. As the mutual aid instinct, shot through with representative quality, is gradually giving place through the consciousness of kind to a representative coöperation, so at the same time the feeling of attachment is passing into the representative feeling of attachment. If we for convenience fixed the rise of the consciousness of kind at the point of restraint on the play impulses, then this fact fixes also the appearance of the representative feeling of attachment in the same situation.

The Representative Feeling of Attachment. — Now that we have reached the period when creatures are in the above sense conscious of kind, we come into the full presence of the facts that evolve the feeling of attachment. On the cognitive side the individual's movements of attention have grown to include the presence and vigilance of his fellows. He now buries his head in the grass, or ruminates placidly in the shade, for he relies most fully upon the other creatures of his kind to apprise him of an enemy's approach. On the motor side the creature's attitudes of resistance have been modified to include corresponding attitudes of his fellows. When an enemy actually appears each shares the burden of resistance; and thus the creature becomes, on the motor side also, thoroughly dependent for his salvation upon the aid of his fellows.

This fact of acting shoulder to shoulder in defense and attack must have a deep and subtle influence in stimulating the creature's feeling of attachment for his fellows. The feeling of attachment in all its fullness and intensity doubtless springs from the very necessity which creatures have for each other when the mutual aid instinct has emerged and they have formed habits of coöperation.[1] Creatures come to need each other, expect each other at certain times and places, just as much as they

[1] 'The Emotions and the Will,' p. 64. In this connection we may refer to the observation recorded by Prince Kropotkin (*lib. cit.*, p. 706) how that, when confidence of a herd has disappeared and the herd disbands, the individuals are apt to perish (*vide* also Sutherland, *lib. cit.*, Vol. I., pp. 323–4).

need food and drink. "The gregarious situation," writes Dr. Bain, "if allowed full scope, would bring about a complete identity of the individual with the flock; there would never be a thought of acting alone or apart from the body."

Furthermore, the need of the life together and the corresponding feeling of attachment is certainly intensified when the individual once experiences the pain of isolation. Creatures like the Damara cattle, which from the exigencies of their life have come to rely almost absolutely upon each other in defense, feel the woe of isolation when thrown upon their own resources. "An ox," writes Mr. F. Galton,[1] "when separated from his herd, exhibits every sign of mental agony; his glance is restless and anxious and is turned in succession to different quarters; his movements are hurried and agitated, and he becomes a prey to the extremest terror. * * * Thus the ox cannot endure even a momentary separation from his herd. He strives with all his might and main to get back, and when he succeeds, he plunges into the middle to bathe his whole body with the comfort of closest companionship."

It is this felt need of the life together, which has sprung up with the social relationship and grown with the evolution of the mutual aid instinct, that gives rise to the feeling of attachment. With this sketch of the feeling of attachment we may now consider very briefly its relation to the general problem.

The exact moment in the defense-reaction for the feeling of attachment is likely at the point when, the motor attitude being reinstated, the creature desires its completion in the aid of the other creatures. The one creature, as soon as the reaction sets in, looks for the others, for he has accommodated himself so as to include these others in his activity. The expectancy and the need bring into operation the feeling of attachment, which then reacts upon the motor attitude and establishes it. Strictly speaking, the feeling of attachment does not produce sympathy; but, being what it is, the feeling of attachment draws creatures together and keeps in the focus of attention the attitude of each other. It is the feeling of attachment which gives sympathy its irresistibleness, so that it appears to be, as Professor

[1] 'Inquiries into Human Faculty,' 1883, pp. 72, 76.

Bain has thought, 'a remarkable and crowning instance of the Fixed Idea.'[1]

In order to show as clearly as possible the essential nature of the feeling of attachment, we have considered it in its original signification, as confined to the mutual aid instinct. Whenever mutual aid functions along the line of any motor attitude, there functions the feeling of attachment; moreover, wherever a motor attitude that reckons upon or includes within its course a similar motor attitude of a fellow-creature even *tends* to be reinstated, as in play or in repose, there is also reinstated so far the feeling of attachment which drives creatures together in their common cause. On the other hand, it would be missing a very necessary distinction, especially in the relation of attachment to tenderness, if we did not explain that the feeling of attachment persists as by its own weight, and functions as an impulsive sort of passion after the mutual aid instinct has for one reason or another ceased to function. For example, Mr. Gilbert White[2] has observed that cattle, thoroughly domesticated (and having, therefore, no need of mutual aid), will leave the richest pasturage in order to be with other cattle. This fact seems to show a remnant of the primordial feeling of attachment, springing up with the mutual aid instinct. In connection with tenderness we shall have occasion to enlarge more fully upon this fact.

Tenderness.

We may bring the discussion under three specifications.

1. Tenderness is a feeling peculiar to a state of repose (cessation from all struggle for existence). Dr. Bain emphasizes 'the suitability of the state of repose to the enjoyments of tenderness.' In the 'Emotions' (p. 128) he writes: "The pleasures of slow movements, repose after exercise, repletion, agreeable warmth, sweet odours, gentle and voluminous sounds, mild sunshine, are of the soothing or quieting kind; they induce the conditions of repose and inspire tenderness."

2. All things considered,[3] it probably can never be said that to touch a fellow-being and feel tenderness is in the same cate-

[1] 'Emotions and the Will,' p. 121; also 'Mental and Moral Science,' 'Contiguity' (Bk. II., Ch. I.), sec. 13; 'Sympathy,' Bk. III., Ch. II., sec. 5.

[2] 'Natural History of Selbourne,' Letter XXIV.

[3] *Vide* p. 67.

gory as to touch a stone and feel coldness. Tenderness must always have had some social quality. At the first, and so long as social consciousness is organic, tenderness will be extremely vague and incoherent. After the consciousness of kind has arisen, before it has attained self-conscious form, we may suppose a comparatively large social quality in the tender feeling. At the same time, bearing in mind the meaning of repose and the function of the social relationship in keeping creatures *en rapport*,[1] it is plain that tenderness, being peculiar to repose, cannot be distinctly or coherently social, so long as the social relationship subsists merely or largely in the mutual aid instinct. It will not be coördinated social tenderness until that period when the consciousness of kind is strong enough to persist in seasons of repose. Then tenderness will become distinctly social, for then, it is clear, there will function a social relationship through the consciousness of kind.[2]

3. Tenderness is both organic and representative. The same condition, the consciousness of kind, which makes tenderness distinctly social, makes tenderness representative. Thus tenderness never passes through such a distinctively organic *social* period as feeling of attachment does when it is organic; it is predominantly non-social, and when it becomes social it at the same time becomes representative. Moreover, it becomes representative at a later period than the feeling of attachment; for while the feeling of attachment, functioning in action, develops out of the same conditions which develop the consciousness of kind, tenderness, as we see, becomes representative, distinctly representative, only after the consciousness of kind in its through-going self-conscious form has come into existence and is thus able enough to function and constitute a social relationship in a state of repose. Consequently the feeling of attachment will be representative at a time when tenderness is hardly at all emancipated from the thraldom of the organic.

In the light of these specifications with respect to tenderness, we may now very briefly consider its manifestations and then its

[1] *Vide* p. 74 f.
[2] *Vide* p. 81 f.

relation to the problem in hand. Tender feeling shows itself by a fundamental mode of expression, the movements of attraction and the seeking for contact. According to this test alone, we should place tenderness at an advanced period of life. But there is another and more determining cause of the comparatively late appearance of tenderness. It is that tenderness on its physiological side seems to be a distinct outcome of warm-bloodedness.[1] Considering, therefore, that lower orders of life, the insects, the fishes and the reptiles, show little evidence of the attractive movements of approach, which is the sign of tenderness, we shall take the period of warm-bloodedness as the point at which tender feeling comes into being.

Tender feeling, while functioning in repose, seems to draw its excitant from out 'the struggle,' it may be considered[2] in large part due to the very set-back from the life of coöperative action. Consequently we can best understand its origin from the view point of coöperations. We will imagine that a motor attitude of defense has been reinstated and with it the feeling of attachment. The creatures, struggling together in a common cause, are sensible in a vague way of their mutual resemblance and the solidarity of their end. The hostile force is repelled, the coöperation ceases, and the creature settles into repose.

The social relationship, so far as the serious business of life goes, has now indeed lapsed, but not so the social consciousness in its entire workings. Principally the feeling of attachment, howsoever self-regarding in itself, must needs persist as a vague social feeling after its original purpose has been achieved. We have already anticipated this in speaking of the feeling of attachment itself,[3] and we may now reinforce it from the standpoint of tenderness. For example, the ruff[4] which remained 'inconsolable' until returned again to its mate, must have felt attachment for its fellow ruff, and this feeling, if it ever vented itself, must almost inevitably have passed into tenderness. As M. Ribot has pointed out,[4] 'the primary tendency (to tenderness) is di-

[1] *Vide* p. 48, also Sutherland, *lib. cit.*, Vol. II., pp. 235, 251.

[2] Bain, 'The Emotions and the Will,' p. 125.

[3] *Vide* p. 64.

[4] Romanes, 'Animal Intelligence,' p. 246.

[4] *Lib. cit.*, p. 237.

rected in children and animals to those who have been pleasant to them, or who have done them good and from whom they hope to receive it again.' Thus the feeling of attachment, viewed from the standpoint of tenderness, will stand for 'a mass of agreeable feeling' aroused by the mere presence of the kind, which will readily pass into tenderness.

Now that the hardship of the struggle is over, the perception of these kindred beings, intensified by actual contact of body with body, must awaken the thrill which betokens the tender feeling. Tenderness felt in the sight and the sound, the smell and, above all, the touch of fellow-beings, immediately seeks an outlet which is again this very bodily contact. 'Touch,' as Dr. Bain says, 'is both the alpha and the omega of affection.' Touch is at once the keenest stimulus to tenderness and also the characteristic mode of its expression. The expression of tender feeling we consider a form of play, for play takes not only the form of the mutual aid instinct, it may take any form or no form, and may rest upon the indefinable border-land between activity and repose. It is in such playful impulse that tenderness is expressed and maintained and finally brought to mature or habitual modes of expression.

The importance of tenderness in the functioning of sympathy we can best point out by showing its relation to the consciousness of kind. When we recall that consciousness of kind functions in situations where the impressions of other creatures (considered as such) fills the individual's field of attention, and that the typical situation is the state of repose, then it is clear that tenderness is apt to be present as a background in every thorough-going consciousness of kind. Even though the characteristic emotion of the consciousness of kind, when it passes into sympathy, is the feeling of attachment; yet, the individual's condition being not real but sympathetic, he retains throughout, to a greater or less extent, his condition of repose, and with it his tender feeling for the one sympathized with.[1]

It is at this point that tenderness differentiates itself from the feeling of attachment. While the feeling of attachment springs out of a situation that aims at individual-conservation, and does

[1] *Vide* p. 79.

no more than throw individuals together, tenderness seems to have no end but the other creature. With tenderness we pass beyond the period of the purely egoistic emotions, for in view of its end tenderness terminates upon another creature; and this to a great extent determines the inneity of the altruism in 'vicarious' sympathy.[1]

With this conclusion we have arrived at a statement of the conditions underlying sympathy, so far as these conditions are evident in the gregarious social relationship, taken alone or apart from the domestic relationship. In the entire investigation the consciousness of kind is central. It is seen that the evolution of the affective factors hinges upon the evolution of the consciousness of kind. Moreover, if the foregoing argument is any forecast of the rise of sympathy, it is also to be seen that the sympathetic reaction itself is to a great extent an outcome of the consciousness of kind. Therefore, in the ensuing discussion the consciousness of kind will resume its central position and be the center of attack upon the problem.

So far as the gregarious relationship has yet evolved we are able to observe: (1) In the life of activity (work or play) the consciousness of kind is tentative, and at best short-lived. Outside of play and the enforced restraint on play, which is brief as well as infrequent, there will be little occasion for the consciousness of kind. (2) The form of relaxation called repose, where we shall eventually expect to find a clear expression of the consciousness of kind, shows to a large extent only blank indifference and individualism. As already stated, the consciousness of kind is still too weak to rescue repose and save it for further growths of social consciousness and sympathy.

The reason why the consciousness of kind remains necessarily so stunted in the gregarious relationship when taken alone, has been already attributed to the irrepressible activity of the creature while in social relations under the rubrics of the mutual aid instinct. Mere susceptibility to sense impressions (something not lacking even at this stage of mental evolution) is not sufficient for a consciousness of kind. The creature must needs interpret these impressions of other creatures at their real

[1] *Vide* Ribot, *lib. cit.*, pp. 234, 236.

worth; *i. e.*, in such a way that he may recognize these perceived movements, sounds, etc., which are part and parcel of his instinct of self-conservation, as belonging to other selves. In order to find the occasion for such interpretation we now turn to the domestic relationship.

CHAPTER V.

Rise of Sympathy in the Family.

Coördination of Conditions.

The general instinct or impulse for the conservation of the species, when it reaches the plane of the domestic relationship, operates in the form of two instincts: viz., the sexual instinct and the parental instinct. Mr. J. Arthur Thomson[1] in saying, 'The love of mates broadened into parental and filial affection' seems to believe that the parental affection (tenderness) springs from the sexual instinct. We believe on the contrary that parental tenderness, so far as it is organic, needs no other explanation than the sensations of softness and warmth, which the mother feels when in bodily contact with her offspring. But just as little can we think that parental tenderness, after it has become representative and social, is the effect of sexual feeling after it has become 'the love of mates' or conjugal tenderness. A study of birds shows that parental tenderness sprang up as a variation upon the demand of infancy; conjugal tenderness meanwhile arose very largely, as one of its consequences, in the common care of the eggs and the young. For this reason, and also because the parental feeling is confessedly 'a more potent socializer than sexual feeling' (Bain), we consider that the parental takes precedence; and we shall expect to find the consciousness of kind first in the functioning of the parental instinct. Parenthetically it may be added that, if the consciousness of kind is found first in the parental relationship, then conjugal tenderness is indebted not only for its occasion to the parental instinct (in the common care of the young), but also for its very beginnings; that is, the consciousness of kind, with its accompaniment of tenderness, will be transmitted for the parental, and mere sexual feeling will then pass into conjugal tenderness. On the other hand, the fact should not be overlooked that when the consciousness of kind has once arisen, it will present more en-

[1] 'The Study of Animal Life,' 1896, ch. 6, sec. 2.

during features in the conjugal than in the parental relationship; for the conjugal is a reciprocal relationship, while the parental is, as the term implies, one-sided.[1]

Turning now to the parental relationship there are one or two general considerations to be mentioned. (1) We are reminded that the parental instinct has its beginnings with the echinodermata, 'which carry their eggs about, adhering to their body.'[2] In view of this fact the parental instinct appears contemporaneous with the gregarious social relationship; but at a level of mental evolution below the mutual aid instinct, as we have defined it.[3] At the same time we are obliged to say that it has been evolving all this time *pari passu* with the evolution of the gregarious social relationship, each in turn influenced by the other. (2) We have found that the gregarious social relationship subsists largely in the instinct of mutual aid operating in defense attitudes. The parental relationship, we shall find, subsists in an instinct not only of *defense* but also and just as fully of *fosterage*. It is in the fosterage which the mother gives to her offspring that the consciousness of kind first comes to an expression adequate to produce sympathy.

Springing up at so primitive a period of mental evolution, before instincts have commenced to slough off into habit, the parental relationship anticipates by very considerable time the period of infancy; thus the instinct at its inception is mainly protective in aim. Aside from the preparation of the eggs for hatching, which might be considered indeed a kind of fosterage, it fulfils its function in watching and guarding the eggs, in warding off marauders, and the like. The rise of parental fosterage depends upon that state of abject helplessness in the offspring which we call infancy.[4] The new-born brought into

[1] For a discussion of the conjugal relationship *vide* Sutherland, *lib. cit.*, Vol. I., ch. 7.

[2] Ribot, *lib. cit.*, p. 279.

[3] *Vide* p. 36. This statement should not, however, be considered as yielding a point to the theory that a social relationship arose first out of the family. The position here taken is that the social arises independently of the domestic relationship, and develops under the rubrics of the gregarious instinct. The domestic relation does much, as we are now proceeding to show, to strengthen the gregarious social relationship.

[4] As to the causes of infancy I can do no better than to refer to the admirable account of the influence of intelligence and conscious imitation upon inherited

the world in such a condition needs at every point the fostering care of the parent.[1] Thus the earliest form of the parental instinct, expressed as simple defence, now alters or enlarges to meet this new demand, and the mother comes into existence. We have now the situation of a helpless young, and a parent that both protects its offspring and also nurtures it.

While it is with the period of infancy that the parental relationship really begins to take shape (because it is the helpless young that elicits alike fosterage and protection), yet it is not these first expressions of the parental relationship that contribute a new impetus to the consciousness of kind; these first expressions are instinctive, and considered as such they are in no wise different from any primitive instincts for physical self-preservation. The eggs or the young are not felt by the mother as other than part of herself, and the defensive attitude that may arise in behalf of the offspring is no more than an instinct in the mother to preserve herself; and the same may also be said of the earliest fosterage (suckling the offspring).

It is only when the young begins to grow in the image of the mother that the parental relationship will be able to effect a growth in the consciousness of kind adequate to sympathy. Considered, therefore, that this period of the offspring's life has been reached when it has assumed some individuality and resemblance in form of body and expression of thought to the mother,[2] we observe the alteration that takes place in the self-consciousness of the mother, first on the side of nurture or fosterage. We presuppose that the mother has come abreast

or stereotyped instinct given by C. Lloyd Morgan, 'Animal Life and Intelligence,' pp. 452–3.

[1] As to where in the race development infancy arises, there is much uncertainty. The present position inclines rather to the view of Sutherland (*lib. cit.*, ch. 1) that in so far as infancy is conditioned by the rise of the representative consciousness, we fix its rise not lower than but as low as the fishes. That there is so slight a manifestation of infancy upon this level, comes obviously of the fact that representative consciousness is still such a slight factor of life. As we know from the facts of natural history, infancy is first clearly manifested upon the level of the warm-blooded types.

[2] This resemblance would arise, in general, from the fact that the young belong to the same species as the mother; but much more from the fact that the mother has been duplicated by the young in *imitation*.

of her full heritage of self-consciousness, as forecast in the preceding pages.

Rise of the Consciousness of Kind.

Suppose the absence of all hostile force: the maternal instinct on the defensive side is quiescent. The maternal instinct on the nutritive side is active. The massive pleasures of tender feeling are felt to the full, for the young is now like the mother, and every touch, every sound and movement even of her young will minister to tenderness and thrill the susceptible mother-consciousness. We may picture the mother at tender play with the young, or the young at play alone; whatever the situation may be, the young, just because it is her young, occupies the focus of maternal attention throughout a prolonged period of time. For the same reason also her attention is self-forgetful. This is the important fact. This is the fact which brought us to investigate the domestic relation, and again this fact obliges us now in the domestic relation to turn, not to the young in its play, for play is a matter of life and death to the young, but to the mother. Whatever the dialectic of self-consciousness may be, the mother's attention terminates not upon herself, but upon her young.

It is thus that the mind of the mother, 'intensely possessed with the image of the young,' its attitudes and expressions, begins gradually, 'by dim associations and vague comparisons, actually to recognize herself in the young. This recognition means, in the first place, that the mother perceives in the young traits like those she has already perceived in herself; but more than this, it means that the mother becomes conscious of the young no longer as mere body in spatial distinction from her own body: she becomes conscious of the young as really and truly herself. It is the 'eject' of herself — the alter-ego. This identity — the identity of the subject's own felt body and the presented body — is the characteristic moment of the consciousness of kind. At the same time it must be borne in mind that bound up in this consciousness of identity there is also the consciousness of difference. As already anticipated in the Introduction, the mother perceives herself in the young, which makes the young irrevocably herself; yet just because the young

is perceived as it is, another creature separate and distinct from the mother, the mother's notion of herself does not cover her notion of the young. The mother, at the same time that she is conscious of the identity, is conscious that there is more of the young than in the identity. The young, at the same time that it becomes herself, becomes also another self, having a character and individuality of its own, yet bound all the time to the mother in the mother's consciousness that the young is herself, as she at that moment pictured herself. We say 'as she *at that moment* pictured herself'; for it should be borne in mind in this interpretation of the consciousness of kind that the recognition at this comparatively low level of mental evolution is not a recognition in terms of a general notion. The mother has not a general but a receptual[1] self-consciousness; and when she recognizes herself in her young, it is a recognition of herself in certain *definite* situations.

When we reflect upon the course of the argument, it appears that we have accounted for the consciousness of kind by the same processes used in the account of sympathy. This is due to the fact that the consciousness of kind is precisely the recognition of one's self in another, which we considered in the definition to be the determining condition of the sympathetic reaction. In saying that the consciousness of kind is a determining condition of sympathy, we do not mean that it is the sole condition or the entire account of the conscious content underlying each and every sympathy; for inasmuch as sympathy functions in a situation of repose, it is plain that tenderness — the characteristic emotion of repose — is also a condition of sympathy. It seems, then, that consciousness of kind, accompanied by tenderness, is the complex consciousness underlying sympathy. But even this statement must be qualified, for it applies only to the sympathy of the domestic relationship. The feeling of attachment has dropped out of consideration in this discussion of the domestic relationship, but yet it is none the less a factor of the gregarious relationship, and it forms a constituent part of the consciousness underlying gregarious or social sympathy. Thus it will appear that there is a different quality or feeling-tone in social sympathy than in domestic sympathy.

[1] Romanes, 'Mental Evolution in Man,' pp. 34, 40–43.

The relation of tenderness to consciousness of kind at this point it is well to emphasize again. Tenderness, as the characteristic maternal feeling in time of peace and repose, operates from the first in the care of the young. By it the mother was led to observe her young, whence the consciousness of kind arose. With the recognition of self in another, which is the consciousness of kind, tenderness becomes at once social and representative. The mother in the experience of tender feeling at the same time feels that these, her offspring, are of her kind. In each perception she perceives herself, and the impelling power in tenderness is the consciousness of kind.[1] Thus tenderness is, in one view, the cause of the consciousness of kind; in the other view, it is the effect; or, to put it less paradoxically, organic tenderness, a condition of the consciousness of kind, passes into an emotion of tenderness through the function of the consciousness of kind in repose. If we consider, without unnecessary analysis of these notions, that tender emotion is an expression of the consciousness of kind, then we may speak from now on of the consciousness of kind constituting a social relationship in repose[2] through acts of tenderness.

Tenderness takes various forms, adapted to the habits of nurture, peculiar to the parental instinct of the species in question. The mother bird we see, stroking out the scanty feathers of her brood; the mother dog we see, licking her young; the mother monkey does this too, and also plays with her young, and enjoys the embrace in a manner quite analogous to the human mother. Each one of these expressions of maternal affectionateness becomes a distinct motor attitude, existing not for the sake of the individual as such, but for the sake of a fellow creature. Moreover, as the consciousness of kind functions in each attitude of tenderness, we consider that the social relationship has now come to expression in the states of repose. If it be borne in mind that it is in repose that sympathy is made possible[3] — repose that is not indifference, but tender interest like the present — then there is still needed, under such condi-

[1] *Cf.* p. 81 f.
[2] *Cf.* p. 59.
[3] *Cf.* p. 10 f.

tions, only the specific situation, such as is portrayed in the Introduction; and the mother will pass into sympathy for her young.

With this outcome we have a fair statement of the conscious content immediately underlying sympathy. Since our main object is the rise and function of sympathy in the gregarious social relationship, we might very properly proceed now to show how the domestic relationship may serve to bring social sympathy into existence. On the other hand, as sympathy, we find, arises or functions first in the domestic relationship, it will elucidate the main investigation very much if we carry the discussion of sympathy in the domestic relationship on to its conclusion. Then we shall understand more thoroughly the exigencies of the main investigation.

Rise of Sympathy.

Sympathy, while distinctly conditioned by repose, is not in its actual operation a matter of repose as repose is here defined.[1]

Sympathy, let it be said, is a reflex of life and action. Sympathy is not relief from the struggle for existence, but participation in the struggle *as seen in another*. Therefore, it is not in repose as such so much as in repose from the struggle for self that a sympathy operates. In view of this fact, the statement we have made of the consciousness of kind in repose is introductory to the other aspect of the parental relationship, *i. e.*, the parental defense, to which we turn in order to show the rise of sympathy in the domestic relationship.

The defensive attitude of the parental instinct we found at first to be merely a form of the presocial instinct for individual preservation, because to the consciousness of the mother her eggs or her unformed young were but part and parcel of herself. With the emergence of a more mature consciousness of kind it is plain that the character of the parental defense has altered. Now when the mother fights for the young it is no longer as for something felt to be like food and drink, but for something felt to be a fellow creature. At the same time the sympathetic reaction, under conditions of real struggle, is so

[1] *Vide* p. 49.

slight that we will disregard it here[1] and suppose a special situation in which the sympathy is very striking.

When the hostile force X has been repulsed, the further attitude of the mother toward the young will be either parental tenderness or parental defense, according to circumstances. As a special case in point, suppose the young has been wounded. It utters cries of pain and writhes in torture. It was just such cries and movements that first aroused the motor attitude of defense in the mother. As they continue, the motor attitude with its feeling accompaniment continues to be reinstated, howbeit there is no longer a hostile force, and hence nothing to defend. Now if the mother, at the same time that she continues to reinstate the motor attitudes of resistance, realizes that she herself is in safety, the situation is plainly sympathetic; for how can she continue to experience movements of resistance and feelings of anger, realizing all the time that she herself is in safety, except as they are reinstated for the sake of the young, and in the reinstatement are at once referred to the young?[2] This we consider a possible situation in the history of the race wherein sympathy might arise. But it would leave the situation only half stated if the 'vicarious' sympathetic *expression* of the mother were left unnoticed.

It is certain that just so long as the cries, etc., of the young continue, a motor attitude of some sort must operate in the mother, and we have no reason to believe that this particular motor attitude of resistance will cease to obtain (even in spite of the fact that there is no longer a hostile force present) if it were not for the prior claims (prior, now that there is no hostile force present) of another motor attitude, viz., that of parental tenderness. This is really and truly a motor attitude; for, as will be recalled, the same sense-organs which stimulate resistance and anger do also in times of repose stimulate tenderness, expressed in definite motor attitudes of licking, stroking, embracing and

[1] *Vide* p. 82 f.

[2] Compare with the above the statement by Professor Baldwin, 'Social and Ethical Interpretations,' Appendix D, that the objective reaction of sympathy ('social' organic imitation) becomes subjective sympathy in so far as A comes to realize a distinction between a case where he is merely the observer of an attack on B, and a case in which he is himself threatened by X.

the like. We may therefore believe that the sympathetic state will subside, or rather will emerge into the volitional state of parental tenderness. The parent who was defending is now attending the young; 'the fiery enthusiasm has passed into brooding tenderness,' and to the best of her ability the mother is assuaging her young one's distress. In this final output of tender feeling expressed in definite attitudes which are at once social and representative, we have what is called the *vicarious* expression of sympathy.

We now sum up the contribution of the parental relationship to sympathy. (1) In fosterage: (*a*) The feeling of tenderness as expressed in certain motor attitudes of parental affectionateness is *sui generis* in the history of the race, for it is not evolved in behalf of the individual — including others merely as a useful variation—but in behalf of a fellow creature. Primitive organic tenderness aroused by the sense of touch is much strengthened in the mother by the evolution of the other sense-organs in the young. (*b*) We have the rise of the consciousness of kind, as the mother's recognition of herself in her young. This consciousness of kind functions in fosterage and also in defense. (*c*) The consciousness of kind functioning in specific motor attitudes constitutes what will be a social relationship while the creatures are in repose. Its characteristic emotion is tenderness. (2) In terms of the consciousness of kind, the mother *defends* her young. The attitude of defense becomes sympathetic when it is reinstated, not in recognition of a hostile force, but solely in recognition of the signs of the hostile force, emitted at the time by the young. In the full cognizance of safety, the mother feels as she felt when in danger, upon perceiving the cries and movements of her young. The emotions accompanying the motor attitude center not about herself but about her young, in whose welfare her interest is fixed; and this is sympathy. Finally, the parental relationship returns from defense to fosterage with the infusion of tenderness into her parental attitude toward the young, which gives the sympathy its vicarious expression.

CHAPTER VI.

Rise of Sympathy in the Race.

We have now indicated in briefest outline the contribution to the rise of sympathy in the race from the side of the parental relationship. With the exception of the feeling of attachment (the feeling peculiar to coöperation in the gregarious social relationship) the parental relationship has brought the conditions to sympathy to their full stature. With these results in hand we may now proceed to our end-object, which is the rise and function of sympathy in the gregarious social relationship.

The question may be stated thus: How do these conditions, which have produced sympathy in the parental relationship, get carried over into the gregarious social relationship, and how are they wrought into the warp and woof of the gregarious social relationship, so as to supply its present lack and produce sympathy? This effect is clearly possible, in the first instance, only in so far as the parental nature will survive and continue to a greater or less degree to function after its excitant — the helpless young — has ceased to exist. In the first place, we have already had reason to state that parental defense, in its simplest forms at least, will strengthen the mutual aid instinct, and it seems unreasonable to suppose that the parental relationship in its mature form should die out utterly so soon as the young grow up and pass into the larger life of the gregarious relationship. In particular, the tendency of a herd to mass at a weak point of the defense may to a certain extent be accounted for by the persistence of parental defense in the gregarious relationship. We should also cite Brehm's account of how a baboon saved, at the risk of his life, the life of a younger member of the band, as an instance in support of this view (*vide* p. 87). In the second place, the domestic relationship becomes in time more than the parental relationship, and we would do the domestic relationship an injustice should we fail to incorporate the conjugal and

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[1] A. T. Ormond, *lib. cit.*, p. 256.
[2] *Vide* p. 75 f.
[3] 'Lehrbuch d. Psychologie,' 1895, Vol. II., S. 380.

especially the filial aspects. Conjugal tenderness and sympathy we have considered an effect very largely of the parental relationship, in so far as the parents work together in the care and protection of the young. Besides the intense tenderness bound up in the sexual feeling after the consciousness of kind has reached maturity, and largely because of this tenderness, sympathy in the conjugal relationship will be peculiarly well marked. Although in the higher forms of monogamy the influences of the conjugal relationship upon society are beneficent, yet at this stage it is 'without expansive force of elasticity'; it tends 'rather toward social restriction than toward social expansion.'[1]

The filial relationship concerns the problem very especially, because the offspring are learning these traits of the mother directly in view of the larger life of the kind; indeed it might be said that, just in proportion as the young acquire the habits of the mother, they will live less and less to the domestic relationship, more and more to the gregarious relationship. The imitation of the mother, whereby the young acquire the habits of the kind produces, as already explained, a distinct self-modification. The young not only sees the mother, but comes through imitation to feel the way she does, and in the seasons of repose so characteristic of the domestic relationship the young in a dim way will recognize itself in the mother. There again, then, the consciousness of kind comes into being.[2]

The consciousness of kind, at first vague and tentative but constantly increasing in intensity and in coherency, the young now carries with it into the larger and more varied life of the gregarious relationship. We have considered that the consciousness of kind first arose in play and the restraint upon play and reached maturity in the domestic relationship. It is also emphatic to notice that in the young this experience of the race is now reduplicated. As the young enters the larger circle

[1] Ribot, *lib. cit.*, p. 279.

[2] J. Mark Baldwin, 'Mental Development in the Child and the Race,' pp. 123–4, points out that the child, when imitative, is 'hesitating and watchful.' "The infant waits to see how others act." From this observation it is seen that the consciousness of kind emerges in ontogeny through a situation of 'restraint' analogous to that in phylogeny.

of his kind, his consciousness of kind gains content and character from out the struggle for existence. As he fights with his fellows the common battles of life (either real or playful), he is brought into conscious, end-seeking relations with the others of his own kind. His conscious self grasps its fellow along with itself,[1] which gives the creature real experience of what it means to be of a kind with others. The consciousness of kind, being thus experienced in the life of coöperation, becomes fully recognized in repose, when the creature is relieved from the pressure of the struggle for existence. Thus we observe that in the gregarious relationship the consciousness of kind, after a manner analogous to its operation in the domestic relationship, becomes able in and of itself to constitute a social relationship. Thus social relationship will operate to a greater or less extent throughout the length and breadth of the social consciousness.[2]

In order to understand sympathy, we should not forget this constant consciousness of kind, with its accompanying feelings of either the feeling of attachment or tenderness (according to whether the creature is in repose or in the struggle for existence). In the words of Professor Volkmann,[3] it is 'eine gewisse Solidarität der beiden Persönlichkeiten' which every sympathetic reaction presupposes. On the other hand, it saves us some perplexity when we consider how rare observable instances of sympathy are in the lower orders, if we remember that as the consciousness of kind arose first not along the line of any and every life-habit, but in defense alone, and reached its first mature expressions exclusively in the domestic relationship; so we cannot expect the creature to be conscious of kind throughout the length and breadth of his life. The creature is never thoroughly social; the creature is never thoroughly and completely conscious of kind; consequently, while the creature having the consciousness of kind in defense (*e. g.*) may on occasion experience a sympathetic reaction along that line, yet he may never (possibly) experience anything but anger and hostility along the line of nutrition (*e. g.*).

[1] A. T. Ormond, *lib. cit.*, p. 256.
[2] *Vide* p. 75 f.
[3] 'Lehrbuch d. Psychologie,' 1895, Vol. II., S. 380.

Inasmuch as sympathy is dependent to so great extent upon the attitude which creatures may sustain toward each other in periods of repose, the clearer the conception we have of this condition, the more natural will appear the rise of sympathy. We have just said that the consciousness of kind operates throughout the length and breadth of the social consciousness; and this statement applies especially to the social consciousness in repose, where the consciousness of kind functions as a social relationship in definite attitudes of tenderness.[1] To put the condition concretely, when I ask why I sympathize with one person rather than with another, and I answer, I like the first better, I am pleased with his face, I have shared with him the sorrows of life and doubled its joys, it signifies the presence of the consciousness of kind in some form or other; it signifies also, as the direct occasion or impulse to sympathize, a deep undercurrent of tender feeling toward the object of the sympathy. From analogy with adult consciousness we believe we have attained some such situation in animal consciousness. When we recall this ever-present social relationship in the consciousness of kind, and at the same time the attachments that leave with the creatures a never-ending need and desire of living together, and when in view of these bonds we picture the warm flow of tender feeling, having no end to the creature's consciousness but its own gratification, and consummating itself in definite motor attitudes upon another creature, we have in view the seed-bed for the upgrowth of sympathy. Adam Smith[2] thinks that such 'affection is in reality nothing but habitual sympathy.' Affection (tenderness), we consider, is in reality nothing but the emotion accompanying consciousness of kind in states of repose. As already pointed out on p. 175, only the situation for the rise of a sympathy is a state of repose. The actual operation of sympathy is that of activity. To repeat our previous statements, the situation for sympathy is determined first by coöperation in work and in play, which gives content and character to the consciousness of kind, then by the expression of the consciousness of kind in reposeful tenderness. Finally,

[1] *Vide* p. 75 f.
[2] *Lib. cit.*, p. 323.

sympathy itself is made immediately possible through the condition of repose on the part of the creature. And then, when sympathy springs up and expresses itself, it functions as active coöperation — coöperation for the self in another. As we come now to point out the sympathetic reaction itself, we understand that the discussion hinges about the consciousness of kind in active coöperations. The two principal factors of the domestic relationship — the parental and the filial — may be considered as interworking in this operation of the consciousness of kind.

The coöperative act will not *appear* different now that it springs from social intelligence than when it was instinctive. The difference is not in the act, but in the motive or the thought that precedes and may impel the act. In the first place, *A* watching *B* for signs of the foe is also conscious of *B* as his fellow creature; this is the permanent fellow-feeling or solidarity-feeling between the two creatures, which we would call potential sympathy. Suppose that the foe appears and *B* gives the warning which signifies an attack. *A* has now reinstated the motor attitude of defense; the feeling of attachment functions, brings the image of *B* into the focus of attention, and *A* is irresistibly drawn toward *B*. This is the instinct of mutual aid in operation, but differs therefrom in that the motor attitude does not pass instinctively into movement. On account of the permanent presence of the consciousness of kind there obtains for a moment, while *A* is still in safety, merely an 'internal excitation,' and in this moment the feelings accompanying the motor attitude center around *B* and the sympathetic reference is made.

It is this fleeting instant of repose before the struggle that witnesses to the birth of social sympathy. It matters not how evanescent the sympathy may be, or how individualistic the actual coöperation may become, the impulse of self-conservation has included the thought of another, which is recognized as a self — identical with and yet distinct from itself; and this thought has yielded a sympathy upon which the coöperation follows. Looked at from the standpoint of this sympathetic moment, we might also say that the coöperation is its vicarious expression. When Dr. Sully[1] speaks of 'active helpfulness'

[1] *Lib. cit.*, Vol. II., p. 111, n. 1.

as 'the most prominent element in the rudimentary sympathy of animals,' he may mean just this conscious coöperation, which, while so largely instinctive, may yet be looked upon, in view of its eventual outcome, as the expression of sympathy.

With this outcome we have in some measure shown the rise of sympathy in the race, and here ends properly the introduction to the ethics of sympathy. It would, however, leave us with very little anchorage for the further investigation of the subject, if the discussion were left altogether without a forecast of the lines upon which the ethical import of sympathy might be determined. Such a forecast we shall now attempt very briefly to make. Our end object will be to show that sympathy may effect a consciously initiated variation upon the existing social relationship (so-called) in coöperations, which will transform the social structure and start a distinctly inner social evolution.[1]

[1] There have been consciously initiated variations upon the social relationship previous to this period. 'Vicarious' sympathy is *sui generis* among these in that it is the first to make the existing social relationship in coöperations worthy of the name; *i. e.*, it is the first to make it inner and conscious—a social relationship, as we humans know it.

FUNCTION OF SYMPATHY IN SOCIALITY.

It will be recalled that the social relationship arose in the beginning as a means for attaining in greater degree or more readily the well-being of the individual. In time the creature became representative, but the consequent refinements of the social relationship also arose and persisted in order that the individual might effect certain adjustments and survive in the impending struggle for existence.[1] Coöperations (so-called) were directed not first of all in behalf of a fellow-creature, but in behalf of the individual, and only included in their course the fellow-creature. Thus the end and aim of the creature remained as in the presocial state; the creature only acted differently in pursuit thereof.

With the genesis and evolution of the consciousness of kind we have discovered a change in the social relationship so far as periods of repose are concerned. While the social relationship up to this time has functioned only in the active life of the creature and lapsed when the need for mutual aid ceased, now the consciousness of kind, having reached maturity, functions during repose and operates as a social relationship in definite attitudes of tender feeling.[2] As Professor Giddings[3] has admirably expressed this condition: "When integration has been accomplished a certain internal necessity obliges the social mind to maintain the union after its original purpose has been achieved. The consciousness of kind is the compelling power."

This social relationship is clearly a consciously initiated variation upon existing social structure. Moreover, it is a variation running distinctly counter to the social relationship as already in operation, for it plainly has not individual self-con-

[1] This includes also such social conscious imitations as may arise at this period. The creature imitates, but it does not follow from the imitation itself that he is conscious of his copy as standing for another self.

[2] *Vide* p. 82.

[3] *Lib. cit.*, pp. 169, 170.

servation as its end; it seems to have no end except the pleasure of expressing tenderness and attachment toward another. This contribution to social structure, from its peculiar nature as terminating upon another creature who is recognized as a fellow creature, is the first step on the road to conscious and inner social evolution. It is the first appearance of anything like society as we know it. Such fellow-feeling and affectionateness does not spring from sympathy, for it is grounded in repose; but in connection with sympathy it constitutes altruism as we know it.[1]

So much may now be said for the first consciously initiated variation upon primordial individualism in social structure. But so much is indeed little contributed to the making of society. Society, if it means anything, means a structure built out of the great life-needs of the creature. It is this thing of activity and struggle that must be varied and transformed through sympathetic and altruistic dispositions, if there is ever to arise a society which is conscious and psychic to its very bone and marrow. Mere tenderness, subsisting as it does in repose — freedom from the struggle for existence — can have little influence upon the active life of the creature. It can do little in and of itself to stem the tide of 'selfish singleness' when creatures are fairly in the 'struggle.'

So far as we can yet tell, coöperations have not lost sight of their original utility, which is individual preservation; and if this be so, then certainly it is the consciousness of kind, operating in coöperations, which is not yet impressive enough to produce a sympathy capable of transforming the social relationship of active life. We have already noted a wave of sympathetic feeling preceding every coöperation, and it is this sympathetic moment to which we look for the rescue of the social relationship in active life from its primordial individualism. What is needed is a consciousness of kind so tender, so susceptible to others, and at the same time so self-conscious,

[1] This aspect of tender feeling as active altruism we have already dwelt upon in speaking of the vicarious sympathy of the mother toward its wounded young (*vide* p. 77). The importance of altruism in the family group, in order to the development of altruism in the political group, is not by any means a new discovery. See remarks upon this fact by Spencer, 'Prin. of Ethics,' Pt. I., § 76.

as to hold steadily in view the other creature.[1] Then in the struggle sympathy will function so steadfastly that the vicarious expression must needs follow and work its change upon the stereotyped mutual aid instinct.

We cannot say that such a consciousness of kind will become normal in the lower orders. At the same time, if social progress proceeds not in a straight line but as it were by leaps of equilibrium, it may be that some genius, some preëminently social animal may appear, whose consciousness of kind will override the instincts of self-preservation and thus transform, in his own consciousness, the social relationship which has been existing for his individual well-being. This transformation when once fixed may become a copy for social imitation; and thus the inner, conscious social relationship will be put fairly on its way.

In order to show an instance (presumably) of the phenomenon in question, we shall cite the case of Brehm's encounter with the baboons: we quote in substance from Darwin's statement of the anecdote. 'A great troop of baboons were crossing a valley; some had already ascended the opposite mountain, and some were still in the valley; the latter were attacked by the dogs, but the old males immediately hurried down from the rocks, and roared so fearfully that the dogs retreated. They were again encouraged to the attack; but by this time all the baboons had reascended the heights, except a young one about six months old, who, loudly calling for aid, climbed on a rock, and was surrounded. Now one of the largest males came down again from the mountain, slowly went to the young one, coaxed him, and led him away, the dogs being too much astonished to make an attack.'[2] In this instance the outstanding features are: the striking coöperation of the band; its failure to assist in the escape of a single individual; the rescue of the individual by a single member of the band. The conduct of the single baboon, thrown into relief against the conduct of the band, might yield the situation we are in search of.

[1] "In order that this feeling attain any considerable degree of development, representation must have acquired a certain vividness, clearness and stability." Sully, *lib. cit.*, Vol. II., p. 104; *cf.* also Spencer, 'Princ. of Psychology,' Vol. II., p. 565.

[2] 'Descent of Man,' Vol. I., pp. 72–73.

It is a striking instance that we see of coöperation in defense of the males. According to our interpretation, there is working a consciousness of kind, so that the creature carries with him into the defense the consciousness of the other creatures as being his fellows. At the same time, the fact that the band does not return to the rescue of the single individual appears to indicate that even though the consciousness of kind may function, yet it is insufficient to effect any material change in the structure of coöperation. The creatures follow the impulse to mass, and the mutual aid instinct continues to operate in its pristine simplicity; meanwhile the member on the rock is left to shift for himself.

The single individual is also conscious of kind, but in a far more thorough-going and able fashion. The old male, with so clear a consciousness of himself in the stranded member, must sympathize and sympathize again, until the rescue ensues. In commenting upon this instance, Darwin writes:[1] "We may, if we choose, call these actions intinctive; but such cases are much too rare for the development of any special instinct." We consider that this act of the baboon is to be accounted for under a new principle, viz., the volitional or vicarious expression of sympathy. 'Vicarious' sympathy, considered solely in the light of the 'fixed idea,'[2] is, to be sure, scarcely removed from egoism; it may be egoism in disguise; but considered together with tenderness, vicarious sympathy is given an unmistakable distinctiveness among conscious states. Tenderness fairly buries the act in another self, and thus makes the altruism of sympathy a state of consciousness, *an und für sich*. Thus the act of the baboon, while a consciously initiated variation upon the existing social relationship in mutual aid, differentiates itself from all other consciously initiated variations (upon the mutual aid instinct) in that it fastens upon another creature; it is really and truly the welfare of this other individual that is the end and aim in view. Consequently, since the end and aim of the mutual aid instinct is self-preservation, this variation will so far transform the social relationship in mutual aid, and further-

[1] *Lib. cit.*, ch. 3.

[2] *Vide* Dr. Bain, *lib. cit.*, p. 121.

more, wherever the two ends clash the altruistic end will so far work to the downfall of the egoistic.

This altruistic impulse, if once set as a copy for social imitation, may react upon the consciousness of kind, enriching and deepening it, to the extent that such acts as that of the baboon will in time become part and parcel of the social environment. Thus the primitive love of self, having become so far a love of of self through others, may in time become 'a native sentiment as imperious under certain circumstances as egoism.'[1] This will certainly start a relationship, which is inner in the sense that it involves each other's very life interests — and that, with conscious intent; the individual will no longer fights against a hostile force, incorporating the aid of others in his own behalf, but fights consciously in behalf of another, as well as in behalf of himself.

This change, it must be noted, does not occur through any loss of activity or vitality. It is not because the creature is less ardently in the struggle, but because the consciousness of kind so bright and warm induces spontaneously the sympathy which transforms his individualism. Beginning at this period, and without error of analogy, it may be said that all coöperation, when intelligent and self-conscious, is grounded, at least to a certain extent, in sympathy, whose expression is this very coöperation; this is the starting-point of society as we know it.

While we have thus strongly put the case in behalf of sympathy, it would be false to the first principles of moral philosophy for us to conclude that with the genesis of sympathy in social interaction the genesis of the ethical nature has been properly explained. The ethical consciousness is to be found right within the individual's own development. If we take a creature in process of developing, we will find that, up to a certain point in the growth, the creature's end and aim is his own individual welfare. Even though social structure has become coherent, and certain constraints are put upon him by his community, yet he retains, under the guise of coöperation, his primordial individualism. By this it is not meant that the creature is necessarily unsympathetic. He may sympathize even to the point of active

[1] Topinard, *lib. cit.*, p. 246.

altruism, but it is a sympathy of leisure and luxury. He does not require of himself any sacrifice for others of the self that is being realized; consequently it may happen that at times, when society enjoins altruism upon him, his motives are mixed. Now when altruism, already a recognized law of social order, becomes intrinsic to the creature's own self-activity, the creature's attitude changes. His obligation and his self-realization are now at one, and from this time on he is so far consistently ethical.

By this it is not meant that the ethical consciousness consists necessarily in the choice of another's welfare any more than in the choice of his own. His consciousness is now ethical, because he recognizes a personal sanction in the obligation laid upon him to be altruistic, and the welfare of others, hitherto a compulsion, becomes as internal to his own purpose as his own welfare.

While his motives in coöperation were mixed, now they are pure. Both lines of action, which he now may hold before him, are equally self-originated and autonomous; therefore the end which he chooses does justice to both. They are grounded alike in the consciousness of his own self-realization. The altruistic attitude, which is the vicarious expression of sympathy, contriving to furnish one great sphere of obligation in the creature's social life, must necessarily always remain a component of the end which is ethical.

APPENDIX.—An actual animal society in which 'the natural language of fear' predominates, is that of the herring. Mr. Sutherland writes:[1] "When 10,000 young herring swim together, the prowling monsters which one of them might fail to see will surely be detected by some one or other out of the huge mass, and when it darts away, its neighbors instinctively follow and the whole swarm is instantly in full flight." At this stage the perception of the creature's fellows is dull, his 'social' organic imitation in consequence sporadic, and the social relationship unstable. In higher gregarious forms, such as sheep, we find the creature's perception of his fellow's defense attitudes keener, 'social' organic imitation habitual and the social rela-

[1] *Lib. cit.*, Vol. I., p. 293.

tionship in consequence explicit and stable. For an enlarged statement of the gregarious social relationship *vide* Spencer, 'Principles of Psychology,' 1887, II., pp. 562, 563, and Galton, 'Inquiries into Human Faculty,' sec. on 'Gregarious and Slavish Instincts,' especially p. 75, commencing, 'But a herd of such animals, when considered as a whole, is on the alert; at almost every moment some eyes, ears and noses will command all approaches,' etc.

Moreover, there is not only this general expectation of movements, etc., signifying the imminence of the hostile force, but also in some forms a special expectation from particular sources. An anxious old male, invariably the first to scent or see the enemy, comes to be singled out as the proper danger signal. The members of the herd then instinctively count upon his vigilance to save them from the actual presence of the enemy, and thus a real, if one-sided dependence, is set up. This fact of the sentinel, while not very productive in itself, is a valuable adjunct, as we pointed out on p. 55, in the growth of social consciousness.

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The Practice Curve.

A Study in the Formation of Habits.

BY

JOSEPH HERSHEY BAIR, A.M.,
Assistant in Anthropology, Columbia University.

[Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the Faculty of Philosophy, Columbia University, and being Vol. IX., No. 3, of Columbia University Contributions to Philosophy, Psychology and Education. The results of this research were presented before the Section of Anthropology and Psychology of the New York Academy of Sciences, and the monograph is published under the auspices of the Academy.]

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CONTENTS.

THE PRACTICE CURVE.

INTRODUCTION.

(*a*) *The Problem.*

The object of the experiments here described was to investigate various aspects of association, such as the relation between the sensory and motor side of our mental life, the processes involved in the formation and modification of a habit, and, in general, to find a satisfactory physiological and psychological explanation for the phenomena of association.

The experiments were so devised as to determine the quantitative relation of the increasing permanency of an association with the succeeding practices, and also the increasing amount of interference, first when there is an alteration in the serial order of stimuli, and, secondly, when there is an alteration of particular responses to particular stimuli associated by preceding practices. Thus, by means of the interference, quantitatively determined, it was possible to venture a physiological explanation consistent with all the facts of association.

The problems of association are by no means new ones. They received consideration more than twenty centuries ago. Aristotle sought their solution. Scholars of the Middle Ages were concerned with them. The English Empiricists, Hobbes, Locke, Berkeley and Hume, went a great way toward showing how the mind retains and relates its experiences. From Aristotle down, laws of association have been stated, investigated, criticised, modified and adjusted to be consistent with our growing knowledge of psychology and physiology.

With the advent of the theory of evolution, which brought with it a wide range of problems, came again the necessity of reconsidering many problems which had received the dictum and the solution of the past. In the light of evolution all his-

tory had to be rewritten. With it came the biological sciences with renewed vigor and increased importance. Also here the genetic problems had their origin. The study of structure and function became the center of investigation. The processes involved were the chief concern of the investigators, and forms and dogmas lost much of their former sanctity. Men realized the importance of getting their knowledge from nature first hand, and Rousseau's doctrine that we must become good observers received full inspiration. Laboratories of all sorts, among them the physiological, anatomical, biological, and psychological, sprang up and became the *sanctum sanctorum* of him who would know the truth and understand the workings of the mind and the nature of things.

Locke already appreciated that the mental philosopher must have a knowledge of the bodily mechanism and for that reason studied medicine. Berkeley in his 'Essay Toward a New Theory of Vision,' pointed out the importance of understanding the physical laws involved in a perception. Hume showed that the mind connects, classifies and holds in causal relation things which in reality are not necessarily so connected. The spirit of this trio of thinkers can be seen united in the investigations of many of our modern psychologists. It has become imperative, for the psychologist, if he wishes to find solutions for some of the problems confronting him, to be well acquainted with the physiological workings of the bodily organism, and to understand, in a general way, the relations between body and mind, and between movement and thought.

It is interesting to note here the direction experimental psychology has taken within the last few years in studying and emphasizing the importance of the motor element as a factor in mental life. When laboratories for the purpose of psychological research were established experiments were directed generally toward investigating the senses and the sensory side of mental life. If movements were involved, they were studied not as produced but as perceived, much having been written on the sensations, or perception, or memory of movement, but scarcely anything on movement as an indispensable element in mental life. The tide is fully turning, and this ele-

ment is receiving due consideration. The appreciation of the importance of the motor elements is extending even beyond the laboratory, and genetic psychologists, child students, educators and philosophers alike recognize its significance, and the movements and activities of children and animals receive different interpretation. Their behavior under given conditions, their attempts to imitate others, their adjustment to new conditions through trial and error, etc., are becoming subjects of interest and discussion. And the observations thus made, and the knowledge thereby gained, tend rapidly to modify educational ideas. New curricula are everywhere advocated which involve more expression and training of the sensori-motor life, such as manual training, drawing, modeling, designing, sewing, cooking, etc., and the general tendency is to substitute '*training*' for *instruction* or *education*. The philosopher, too, is not tardy in emphasizing the importance of our motor reactions. He is becoming conscious of the fact that it is not what man sees, hears and feels that makes him what he is, but the motor-reactions which these phenomena excite.[1] Men who see and hear equally well may differ widely in their character and appreciation because they react differently under the same conditions. The present tendency is to interpret traditions, institutions and race ideals in terms of *motor adjustments*. The experiments reported in this article constitute an investigation into the motor side of association, and the results lead us to a conclusion, fully in line with the present tendency, that our associations are largely sensori-motor in character.

(*b*) *History of Some of the Experiments Made on Problems of Association.*

During the last century many contributions, both speculative and experimental, have been added to our knowledge of association by such thinkers and investigators as Condillac, Kant, Herbart, Mill, Hartley, Wundt, Galton and others whose work

[1] 'Psychology and Life,' Münsterberg. 'The World and Individual,' Royce. Introduction. 'The Development of English Thought,' Patten. Chapters 1, 2, 3 and 4.

bears more directly on our problem. The work of these latter we shall, therefore, briefly review, stating their problems, methods, results and conclusions.

About the first important piece of experimental work done along the line of our problem was that by Ebbinghaus in 1885.[1] He investigated the memory in terms of two of its external conditions—time and number of repetitions. He took 2300 nonsense syllables, containing each two consonants and a vowel, drawn arbitrarily into series of different length. These series were repeated until just learned 'by heart.' He found: (1) That the longer the series the more time spent on each syllable in just reproducing. (2) The more repetitions the less time spent on each syllable. (3) One repetition enough for a series of seven syllables. (4) The more repetitions the fewer repetitions necessary to relearn in the future. (5) Relearning on successive days reduces constantly the time for relearning. (6) Additional repetitions more than required for just learning had better be scattered than concentrated in one day. (7) If the order of the syllables in a series was changed, the time for relearning was increased. (8) The distance of impressions from one another in time and space is of very great importance — greatest liability of reproduction is correlated with direct contiguity or succession. (9) The connection of homogeneous impressions — *i. e.*, belonging to the same sense department means — a greater liability of reproduction than that of disparate. (10) The greater the difference between the group of contents and the surroundings the easier will their unification be and the greater the liability of reproduction. This law is consistent with the law of reaction, that the stronger the stimulation, within certain limits, the shorter the reaction time.

Among the several investigations which Münsterberg[2] has made into association, that one, the problem of which was to find whether a habit associated with a given sensory stimulus can continue automatically, while some effect of the previous and different habit associated with the same stimulus remains,

[1] 'Ueber das Gedächtniss.' Reviewed in *Am. Jour. of Psychol.*, 1888–9, p. 587, also in Külpe's 'Psychol.,' p. 178–9.

[2] 'Gedächtnisstudien,' Teil. 1, Beiträge, Heft 4, 1892.

is interesting in this connection. Münsterberg denied that any laboratory method could be applied to the investigation of this problem, and claimed, therefore, that it must be studied from the actions of daily life in order to keep the attention distracted from the experiment. He had always carried his watch in the left-hand pocket and taking it out on that side had become automatic. He now practiced taking it out on the right-hand side until he did it automatically. He then returned to the old habit and found it took less time to relearn this old habit than it did to take it out on the right side automatically, and therefore concluded that some effect of the first habit remained, although the second habit had become automatic. He found that if this process of relearning successively by alternating the habits is continued, the time for relearning each habit grows less and less, following the law of the practice curve. He believes that the sensori-motor impulse does not divide like an electric current, inversely proportional to the resistance, but the whole impulse goes in one direction and that direction is determined by habit — *i. e.*, it goes the course it is accustomed to go.

Müller and Schumann[1] investigated the problem whether it will require more repetitions to relearn a nonsense syllable series if in the meantime the syllables of the series have been associated with another set of syllables. Two sets of twelve syllables each were learned in thirteen repetitions each. The relearning averaged 7.29 and 7.89 repetitions respectively. The second series was united with twelve new syllables, so that each syllable of this series entered into an association with a new syllable series. The fact that the second series was relearned almost as rapidly as the first does not deny the effect of interference. The syllables of the test series were repeated before the final relearning about twice as often as the comparison series and, therefore, there was a greater familiarity with the syllables as such. A considerable part of the work of learning a nonsense syllable series is spent in learning the individual syllables, so that in the experiment the interference effect about offset the practice effect.

[1] 'Experimentelle Beiträge zur Untersuchung des Gedächtnisses,' *Zeitschr. f. Psychol.*, Bd. VI., 2 and 3, 1893, p. 173.

Smith[1] (W. L.) investigated the interference effects of inharmonious utterances on learning nonsense syllables. He had twenty nonsense syllables in series of ten exposed for twenty seconds—immediate recall, errors noted. During the exposure he had the subject count. There were more errors with counting than normally, the relative increase of errors with counting being from 12.6 to 16.7. He also found that characters used by the deaf can be remembered better with than without hand movements.

In studying the economy of learning Jost[2] took two series of syllables. He repeated the first series ten times a day for three days, and the second thirty times in one day, and then relearned them. He found that distribution of repetitions yields better results than concentration. He also found that the earlier repetitions seemed more effective than the later ones.

In an experimental work by Miss Calkins[3] on association, recency, frequency, vividness and primacy of connection, and their relations to one another, were studied. To a class a series of colors was presented, one at a time, through a shield for four seconds each. Each individual color was followed immediately by a numeral. A series of from five to ten colors was thus shown at periods of eight seconds each. At the close of the series the same colors in altered order were shown and the subjects asked, as each color appeared, to write down the associated numerals if any such occurred. About one-fourth of the ordinary combinations in longer series and one-third in the shorter were remembered. The repeated numeral was associated in 67.3 per cent. of the possible cases, the normal in only 24.9 per cent. Thus the frequently combined numeral was associated more than twice as often, while the unemphasized was associated slightly less often than the average. The vividly associated numerals were remembered in about one-half the series, while the normal associations with the same colors were only one-fifth the entire number. The last number was recalled in 53 per cent. of the cases. The other numerals asso-

[1] 'On Muscular Memory,' *Amer. Jour. Psychol.*, VII., 1896, p. 436.

[2] 'Die Assoziationsfestigkeit in ihrer Abhänigkeit von der Verteilung der Wiederholungen,' *Zeitschr. f. Psychol.*, XIV., 1897, p. 436.

[3] 'Association.' PSYCHOL. REV., Monograph Sup., II., 1896.

ciated with the same color only in 25 per cent. of the cases. The experiment showed the swiftly decreasing influence of recency. Primacy was a significant factor only in individual cases; comparison of recency with frequency showed that there was a definite excess of association with frequency. Frequency as a corrective influence granted a sufficient number of repetitions, it seems possible to supplement if not actually to supplant associations which have been formed through impressive or recent experience, a means of combating harmful or troublesome associations.

Another study on the relation of memory and distraction was made by Smith (W. G.).[1] He had sets of letters exposed each for ten seconds, the reagent repeating what he could remember. While memorizing the attention was variously distracted and the results compared with the normal results. Comparison showed the greatest disturbance where the mind was employed in addition during exposure, and that produced by repeating nonsense syllables was greater than that by tapping with the fingers. The relatively large number of errors of insertion and displacement in groups where distraction was greatest emphasizes the importance of the motor factor in memory, particularly in the interference of articulatory innervations involved in memorizing by the activity of the vocal mechanism.

The effect on ideas, feelings and emotions, when intensifying or inhibiting their bodily adjustments, has been studied by Breeze.[2] He found that mental states have an intensifying or inhibiting control over bodily adjustments and that mental states are repressed by the influence of antagonistic motor adjustments. Certain motor adjustments are very important for mental states. Many conscious states show very plainly that they are accompanied, at all times, by particular motor adjustments, and become the basis of mind-reading. In many cases the major part of the content of the mental state is that furnished by the motor adjustment. If their motor adjustments are in any way inhibited the mental states are inhibited.

[1] *Mind*, N. S., IV., 1895, p. 47.

[2] 'On Inhibition,' PSYCHOLOGICAL REVIEW, Monograph Sup., Vol. III., May, 1899.

Bergström[1] made several experimental researches on association, one of which we shall review here as bearing directly on our problem. He sorted a pack of eighty cards into ten piles of eight in a pile, each pile being composed of the same picture. In sorting a pack a second time a given card may be placed into the position it originally occupied or in one of nine other positions. In the first case we have simple practice effects, whereas if in one of the other positions, the pictures on the cards enter into associations which necessarily exclude the former associations, and we have interference. The first problem studied was the rate of decrease of interference with increasing intervals of time, between first and second sortings. An experiment consisted of two parts — first, sorting the pack of cards into piles in given positions, and secondly, sorting after a certain interval of time into piles of entirely different positions. Eight different intervals ranging from 3 to 960 seconds were used. One experiment a day for each interval was practiced at a given hour. He found by this method that the average difference between the three-second and eight-minute interval was 14.28 seconds, and between the one-minute and eight-minute interval 4.72 seconds, which shows that about two-thirds of the decrease took place in the first minute. In twenty-four hours the subject can sort the cards as rapidly as at first. This does not mean that the neural disposition has vanished. The experiment consists rather in raising the habit temporarily above the rest and noting its interference with another raised similarly above the same base of opposition. The curve of forgetting, if we put it at 30 for the three-second interval, would be 45 for the fifteen-second interval, and the decrease in the differences would be between these two points, but after about one and one-half minutes the great decrease in difference is at an end. It takes all the subjects when in practice 65 seconds to sort the first pack, and to sort the second immediately afterward about 85 seconds. This increase in time required to sort the second pack is due to false movements. The errors which the subjects were obliged to make and the consequent retardation show that a strong association had been formed.

[1] 'Relation of Interference to the Practice Effect of an Association,' *Amer. Jour. of Psychol.*, VI., p. 433.

The effect of absence of acoustic motor elements in commiting visual objects to memory was investigated by Cohn,[1] also their presence as distractionary combinations. He placed twelve consonants in three rows of four each. During reading of consonants the subject either (1) pronounced the consonants, (2) suppressed all articulation, (3) pronounced other words or (4) counted. He found that judgments of recognition of order were better than those of recalling letters. Judgments of type (1) better than of type (3). The most common error was one of transposing letters from one to another column in the judgments. Practice improved the ability to recall. Recall was much affected by methods (2) and (3).

Bryan and Harter investigated the learning of the telegraphic language.[2] Their problem was to find the factors involved in learning telegraphy. Their method was one of observation and cross-examination of operators. They found that the student learns to distinguish most of the letters in a few hours, but after distinguishing them clearly at one time he generally finds himself confused by the back stroke and must relearn the letters many times before the difficulty is overcome. As the characters composed of four, five or six dots are made much more rapidly than the learner can count, much practice is necessary before he can be positive of the number of such dots. When a considerable speed in receiving is reached the spaces between the letters of a word become so small that one ceases to recognize them consciously, letters seem to blend together and words are recognized as a whole sound. First the letter is the unit, then the word and finally the sentence. There are distinct specialties in telegraphy so that while an operator may be competent in one department he would be a failure in another requiring no greater speed. It requires from two to two and one-half years to become an expert. The ability to send is usually greater than that to receive. Errors in the transmission of messages are comparatively few. Every operator de-

[1] 'Experimentelle Untersuchungen über die Zusammenwirkung des akustisch-motorischen und des visuellen Gedächtnisses,' *Zeitschr. f. Psychol.*, XV., 1897, p. 161.

[2] PSYCHOLOGICAL REVIEW, IV., 1897, p. 27, also VI., 1899, p. 345.

velops a distinct style of sending so that he can be recognized readily by those working with him. The motor curve is an asymptotic approach to a physiological limit. This limit was called the first plateau; it can be transcended by extraordinary effort and a second plateau can be reached. When an error is once made there is a tendency to repeat it many times.

Miss Steffins[1] studied the easiest method of memorizing 'Childe Harold.' She found stanzas to be most easily memorized by reading through as a whole until they can be repeated.

This brief summary of the work done, the methods employed and the results obtained by the several investigators of this problem of the relation of association to movement, serves to set before us the landmarks already established, and furnishes suggestions as to the best method to be employed in pursuing further researches along the same line.

Methods and Results.

As already stated, the object of the experiments about to be described was to determine the relation between the persistence of an association and the number of times repeated, the relative persistency of connection of a particular response to a given sense impression with the number of times repeated, and finally, the relative permanency of connection with the number of repetitions, between the stimuli that follow in serial order, or the responses that follow in serial order. These relations can only be determined by measuring the interference taking place when a sense impression or a series of sense impressions to which we have previously responded with a definite movement or series of movements are now responded to by a different movement or series of movements.

The method here employed was to practice a series of stimuli, respectively, with a series of responses until these practiced reactions became automatic, or until at a given rate no more errors were made. When this was accomplished, first, the order of stimuli was changed, and the amount of interference ascer-

[1] 'Experimentelle Beiträge zur Lehre vom ökonomischen Lernen,' *Zeitschr. f. Psychol.*, XXII., 1900, p. 321.

tained either by means of the number of errors made when the time was kept constant, or by means of the increase in time it took to run through the series when the errors were kept constant, *i. e.*, at zero; and, secondly, when this new order was practiced until again there were no more errors, when the time was kept constant, or until the rate approached the physiological limit, when the errors were kept constantly at zero, new responses were practiced to the old order of stimuli and the interference again determined in terms of the increased number of errors, or the increased time. The relative rates of adjustment and readjustment, when the order of stimuli or the order of responses to stimuli was changed, were also determined by the number of practices it took to reach zero, when the time was kept constant, or, to reach the physiological limit when the errors were kept at zero.

These experiments were made on a Blickensderfer typewriting machine.[1] To the carriage in an upright position was attached a black screen which moved with the carriage and in which was a narrow slit the width of a letter printed by the typewriter. Immediately behind this screen was a horizontal wooden cylinder two and one-half inches in diameter and the length of a page printed by the typewriter. This cylinder was held in position against the screen by a frame. It could be turned on its axis so as to bring any part of its surface in line with the slot in the screen. Around this cylinder was fastened a white paper on which were printed in six different colors, arbitrarily arranged, a series of fifty-five. This series appeared in a horizontal line on the cylinder, and every time a key was pressed on the typewriter a different color appeared in the slot, due to the movement of the slot forward with the carriage. Immediately underneath this first series (series A), was arranged in a similar horizontal manner a second series (series B) containing the same colors but in a different serial order. A third

[1] Professor Jastrow first suggested capping the keys of the typewriting machine at the New Haven meeting of the American Psychological Association in 1899–00, and in 1901 Dr. Wissler, in some experiments at Columbia, used caps, screen and color series in much the same way I did in these experiments.

series (series C), differing only in two places from series A, was placed under series B.

Underneath these three color series on the same cylinder in a similar manner to the color series were arranged three letter series, A, B and C, made up of six letters, and fifty-five in the series. Any series could be brought in line with the slot by turning the roller on which they were placed.

The typewriter contained three rows of keys. The six middle keys of the first row were covered with caps containing each one of the six colors composing the color series. The six middle keys of the second row were covered with caps containing each one of the letters of the letter series, and the third row of keys was covered with blank caps. A sheet of paper was kept in the machine, and every time a key was pressed the letter of that key was printed on the paper, and in this way the errors were easily determined.

An experiment consisted in pressing, respectively, the keys corresponding to the colors or letters as they appeared in the slot. Either the subject kept time with the beat of the metronome and the errors were scored, or he made his associations as rapidly as possible without errors and the rate was determined with a stop-watch. In the experiments represented on Plate II. the time was kept constant on the color series and the practice or adjustment curve determined by the number of errors, and in the letter series the subject was required to go as rapidly as he could without errors and the practice curve determined from the decrease in the number of seconds required in each successive practice.

The *first experiment* was made before the caps were devised for the keys. It consisted in taking seven letters on the keys, four in the first row of keys and three in the second. These seven letters were arranged in a series of fifty-five. The daily experiment consisted in running over this series three times, the first two times at the rate of one per second, keeping time with the beat of the metronome, and the third time taking the rate with a stop-watch. It took nine days' practice — *i. e.*, going over the series twenty-seven times — to get rid of the errors at this

rate. And the average number of errors in the first practice was twenty-nine.

TABLE I.

Ba.	Errors	37	20	23	11	5	3	2	2	0
		28	13	6	5	3	2	1	1	0
	Time	*81*	*77*	*57*	*64*	*59*	*56*	*56*	*52*	*49*
Me.	Errors	22	7	6	3	1	1	1	1	0
		11	5	2	1	2	1	4	0	0
	Time	*80*	*64*	*57*	*55*	*54*	*53*	*57*	*50*	*47*
Mi.	Errors	50	31	30	26	21	12	7	4	1
		41	26	26	19	14	6	3	0	0
	Time	*88*	*81*	*64*	*59*	*57*	*58*	*56*	*55*	*52*
Sm.	Errors	25	17	11	11	6	4	2	0	0
		21	15	6	2	3	1	1	1	0
	Time	*68*	*65*	*63*	*61*	*54*	*49*	*44*	*42*	*39*
Av. Errors		**29**	**27**	**14**	**10**	**7**	**4**	**2.5**	**2**	**¼**
Av. Time		**79**	**72**	**63**	**60**	**56**	**54**	**53**	**49**	**47**

Table I. shows the results of experiment I. The upper two horizontal columns for each subject represent the number of errors for each day's practice, beginning at the left when the time was constant at one per second; the lower or time column beginning at the left represents the number of seconds it took from day to day when the subject did it as rapidly as possible, without any errors. The first column in black type represents the average errors for the successive practices of all the subjects and the second column the average time. This table shows that the association curve follows the regular practice curve. With practice both the number of errors and the time required to run through the series are constantly decreased until the number of errors reaches zero and the time required the physiological limit.

The *second experiment* was with the color series. It consisted in going over the series eight times each day in succession, the subject keeping time with the beat of the metronome, increasing the rate of the metronome each time, except the last, when the subject did it at the most rapid rate he was able without making mistakes. The daily practice consisted in running over the series at each of the following rates per minute: 60, 66, 72, 80, 88, 96, 104, and lastly the subject's most rapid rate.

A certain arrangement of the colored keys (arrangement A) was thus daily practiced with the color series (series A) until no more errors were made at any of the rates. Then

color series B was substituted for series A, and practiced in like manner until no more errors at the most rapid rate were made. Then the keys were interchanged and the new order (arrangement B) was practiced with series B until all errors were eliminated. Color series B was then again practiced with arrangement A until all errors were overcome, and then, finally, the order first practiced was again returned to and practiced until all errors were once more reduced.

Table II.

A. Series A — Arrangement A.

Rate.	Ba.	Me.	Mi.	Sm.	Av.
60	12	9	20	7	12
	17	*20*	*32*	*16*	*21*
66	13	16	30	13	18
	18	*21*	*28*	*25*	*16*
72	20	18	35	18	23
	31	*35*	*42*	*40*	*37*
80	32	21	38	21	28
	50	*41*	*60*	*53*	*51*
88	37	26	43	36	33
	83	*74*	*89*	*81*	*82*
96	43	34	47	29	38
	95	*92*	*101*	*97*	*96*
104	46	41	48	26	40
	124	*128*	*136*	130	*129*

B. Series B — Arrangement A.

Rate.	Ba.	Me.	Mi.	Sm.	Av.
60	0	0	0	0	0
	1	*1*	*1*	*1*	*1*
66	1	1	5	0	2
	9	*9*	*17*	*2*	*9*
72	2	1	11	1	4
	17	*17*	*25*	*10*	*17*
80	5	3	12	2	6
	27	*27*	*35*	*19*	*27*
88	4	2	22	3	8
	60	*44*	*67*	*44*	*54*
96	6	5	29	3	11
	77	*68*	*85*	*61*	*73*
104	8	9	37	7	13
	86	*86*	*94*	*78*	*86*

C. Series B — Arrangement B.

Rate.	Ba.	Me.	Mi.	Sm.	Av.
60	11	1	8	2	6
	9	*9*	*9*	*9*	*9*
66	17	2	16	2	9
	17	*10*	*25*	*10*	*15*
72	14	4	17	3	10
	26	*26*	*26*	*18*	*23*
80	15	5	21	5	12
	61	*36*	*51*	*36*	*43*
88	15	8	32	7	16
	68	*52*	*68*	*44*	*58*
96	14	13	42	7	20
	85	*77*	*77*	*69*	*77*
104	18	14	46	13	23
	102	*94*	*110*	*86*	*98*

D. Series B — Arrangement A.

Rate.	Ba.	Me.	Mi.	Sm.	Av.
60	0	0	0	0	0
	1	*1*	*1*	*1*	*1*
66	0	0	1	2	1
	2	*2*	*9*	*9*	*5*
72	1	2	8	1	3
	10	*10*	*17*	*10*	*12*
80	2	1	14	2	5
	11	*18*	*27*	*11*	*17*
88	3	2	20	3	7
	19	*12*	*28*	*12*	*18*
96	4	5	21	3	8
	29	*21*	*37*	*21*	*27*
104	5	3	23	5	9
	29	*29*	*46*	*38*	*36*

TABLE II.—*Continued.*

E. SERIES A — ARRANGEMENT A.

Rate.	Ba.	Me.	Mi.	Sm.	Av.
60	0	0	0	0	0
	1	*1*	*1*	*1*	*1*
66	0	0	2	0	½
	2	*2*	*9*	*2*	*4*
72	0	0	0	1	½
	3	*3*	*3*	*10*	*5*
80	1	0	5	0	1½
	11	*4*	*11*	*4*	*8*
88	2	4	5	1	3
	12	*12*	*20*	*14*	*14*
96	5	3	9	4	5
	21	*13*	*21*	*13*	*17*
104	9	7	13	8	9
	22	*22*	*30*	*14*	*22*

TABLE III.

A. SERIES A — ARRANGEMENT A.

No. of Exper.	Ba.	Me.	Mi.	Sm.	Av.
8	62	66	62	55	*61*
16	52	49	57	52	*53*
24	50	54	55	45	*51*
32	49	43	54	43	*47*
40	48	39	49	41	*44*
48	44	37	45	40	*42*
56	44	37	44	39	*41*
64	42	36	43	36	*39*
72	42	37	43	40	*40*
80	44	36	45	38	*41*
88	42	38	40	39	*40*
96	41	36	44	40	*40*
104	41	36	40	38	*39*
112	42	35	41	34	*38*
120	41	36	40	36	*38*
128	40	34	40	36	*37.5*

B. SERIES B — ARRANGEMENT A.

No. of Exper.	Ba.	Me.	Mi.	Sm.	Av.
8	45	40	44	43	*43*
16	44	36	43	39	*40.5*
24	44	37	43	39	*41*
32	39	38	47	40	*41*
40	40	36	42	36	*38.5*
48	38	37	39	35	*37*
56	38	36	40	32	*36.5*
64	39	40	38	35	*38*
72	40	36	37	33	*36.5*
80	40	36	36	34	*38*
96	36	36	36	33	*35*

C. SERIES B — ARRANGEMENT B.

No. of Exper.	Ba.	Me.	Mi.	Sm.	Av.
8	52	48	47	42	*47*
16	46	44	44	42	*44*
24	46	40	44	39	*42*
32	45	41	39	39	*41*
40	44	39	39	37	*40*
48	44	36	40	34	*38.5*
56	40	37	37	34	*37*
64	40	36	35	35	*36.5*
72	40	36	36	35	*37*
80	42	36	35	31	*36*
88	38	36	36	33	*36*
96	37	35	35	34	*35*
104	38	39	35	32	*36*
112	37	37	38	31	*36*

D. SERIES B — ARRANGEMENT A.

No. of Exper.	Ba.	Me.	Mi.	Sm.	Av.
8	36	41	39	31	*37*
16	36	36	35	30	*34.5*
24	36	37	35	30	*34.5*
32	37	35	37	32	*35*
40	35	32	34	29	*33*
48	35	31	33	29	*33.6*

E. SERIES A — ARRANGEMENT A.

No. of Exper.	Ba.	Me.	Mi.	Sm.	Av.
8	35	34	36	30	*34*
16	32	32	35	30	*32*
24	34	31	32	28	*31*

Table IV.

A. Series A—Arrangement A.

104	40	36	31	28	24	21	17	14	11	10	9	7	5	3	3
	7	*7.5*	*5*	*45*	*4*	*3*	*4*	*4.5*	*4.5*	*2*	*4.5*	*2.5*	*2*	*15*	*5*
96	38	33	29	22	18	16	12	8	6	5	4	2			
	7	*4.5*	*5*	*3*	*2*	*2*	*1.5*	*1.5*	*1*	*2*	*1.5*	*.5*			
88	33	24	19	15	13	11	8	7	4	2					
	8	*4*	*2*	*1.5*	*1*	*1*	*2*	*3*	*1.5*	*.4*					
80	28	17	13	9	7	4	1								
	7	*3.5*	*2*	*1.5*	*2*	*1.5*	*5*								
72	23	10	6	4	2										
	6	*3*	*1.5*	*1*	*1.5*										
66	18	7	3												
	6	*1.5*	*1*												
60	12	5													
	4	*1*													

B. Series B—Arrangement A.

104	13	12	12	10	9	7	6	5	3	3	1
	9	*6*	*4*	*4*	*3.5*	*2.5*	*25*	*1*	*2*	*1.5*	*2*
96	11	9	7	7	6	5	5	4	2	.5	
	9	*6*	*4.5*	*5.5*	*2.5*	*2*	*1*	*2*	*7*	*0*	
88	7	5	5	3	3	1					
	7	*2.5*	*3.5*	*2*	*1.5*	*.5*					
80	6	4	3	1							
	3.5	*1.5*	*1.5*	*.5*							
72	4	2									
	3.5	*7*									

C. Series B.—Arrangement B.

104	23	19	16	13	11	10	8	8	6	4	2	.5
	12	*6*	*7*	*5*	*2.5*	*2.5*	*2*	*2.5*	*1.5*	*1*	*.7*	*.2*
96	20	13	11	8	7	6	5	3	2			
	12	*5*	*4*	*1.5*	*2.5*	*2*	*1.5*	*1.5*	*.7*			
88	16	8	6	5	4	3	2					
	8	*3*	*1.5*	*1.5*	*1.5*	*1.4*	*7*					
80	12	5	4	2	1							
	6.5	*2.5*	*2*	*1.3*	*.2*							
72	10	3	1									
	6	*2*	*.5*									
66	9	1										
	7	*2*										
60	6											
	4											

D. Series B.—Arrangement A.

104	9	8	5	2
	7	*4*	*2*	*1*
96	8	7	2	1
	6	*3.7*	*1*	*.2*
88	7	4	1	
	6.5	*3*	*.5*	
80	5	2		
	5	*1.5*		
72	3	1		
	2.5	*0*		
66	1			
	2			

TABLE IV.—*Continued.*

B. SERIES A.—ARRANGEMENT A.

104	9	5	1
	1.5	*2*	*.5*
96	3	2	
	6.5	*1*	
88	1.5		
	1		

Tables II., III. and IV. show the results of the second experiment. In table II. the upper horizontal columns for each rate indicated in the margin, in each of the orders practiced [*i. e.*, Series A, Arrangement A, B–A, B–B, etc.], show for each individual the number of errors, and the average number of errors, in the first practice at that rate, and the columns immediately below in italics, show, respectively, the number of practices required to eliminate all the errors at that rate.

Table III. shows the rate at which each of the subjects could run over the series at the number of practices indicated in the margin for each of the orders, A–A, B–A, etc., practiced.

Table IV. represents the same experiment. In each of the orders, A–A, B–A, etc., the upper horizontal column at each of the rates indicated in the margin represents the average number of errors at each succeeding practice at that rate, and the column immediately below in *italics* represents respectively the mean variation of the errors, at the said rate and number of practices, for all the subjects. The first line represents the mean curve and the second line at each of the rates found in the margin the mean variation of that curve—*i. e.*, see Plate I.

The *third experiment* is represented by Tables V. and VI. Seven students, four of whom served in the first two experiments, acted as subjects. Each subject practiced at one rate only, one subject for each rate, and the old subjects for the higher rates. The latter series, thus far practiced by none of the subjects, were used, only the color series having been practiced by the old subjects. An experiment consisted in going over the letter series each day five times at his respective rate by each subject. Each of the three new subjects also practiced over the color series five times each day in succession as rapidly as possible without making any errors. First letter series A and key arrangement A were practiced together until all errors were eliminated, then the order was changed and practiced until no more errors. The following orders were practiced each until no more errors:

1. Letter series A.—Key arrangement A.
2. " " A.— " " B.
3. " " B.— " " B.

Table V.

A.

Ca.	Da.	Mi.	Go.	Me.	Ba.	Sm.
60	**66**	**72**	**80**	**88**	**96**	**104**
12	25	38	36	38	44	46
16	*21*	*36*	*55*	*52*	*59*	*66*
4	15	22	24	29	32	34
5	*17*	*25*	*41*	*23*	*29*	*37*
0	1	5	7	9	10	13

B.

—3	—6	—14	—3	2	—4	1
—1	—4	—3	—10	2	—2	—3
—2	—4	—1	5	—5	2	2
—0	—3	—4	—2	—2	—4	—6
1	—3	—3	3	3	1	1
1	0	1	—6	1	2	—4
—3	—1	—3	1	—1	1	2

C.

2	—2	—5	2	—6	—3	—5
—2	—3	—3	—5	—3	3	2
—1	—1	1	2	1	—6	—2
—2	1	—3	—3	—4	1	1
	—3	—1	1	2	—5	—2
	—1	—2	1	—3	—2	—1
	—2	1	—2	1	2	—3

Table V. shows the result of this experiment. In section A the numbers below each name represent the rate at which each practiced. The perpendicular column underneath each name represents the results of that subject. The first horizontal column below the rate shows the number of errors made by each subject at his rate in the first experiment, and the second column immediately below in italics, the number of practices required to eliminate the errors at that rate. The next two columns show, respectively, the number of errors in the first experiment and the number of practices required to eliminate them when the keys were changed, and the last two columns proceeding downward when the letter series was changed. Section B of Table V. shows the rate of decrease in the number of errors for each subject with each practice. The columns are to be read vertically below each name at that rate. The upper figures represent the decrease in errors of the second practice over the first, if the figures are preceded by a minus sign, if not preceded by the sign the figures represent an increase of errors. Likewise the second figure represents a decrease in number of errors of the third practice over the second, etc. Section C shows similarly the decrease in the number of errors with the successive practices when the keys were changed.

In the *fourth experiment* on the typewriter three new subjects practiced daily five times in succession the color series for seven successive days. Then the caps were interchanged and the new order practiced in a similar manner five days. Then the caps were placed in the order first practiced and the time ascertained in which the subject could run through the series.

TABLE VI.

	Go.	Da.	Ca.	Av.		Go.	Da.	Ca.	Av.		Go.	Da.	Ca.	Av.
A.	62	79	82	*74*	A.	46	43	49	*46*	B.	53	51	58	*54*
	59	75	68	*67*		47	42	47	*45*		50	50	56	*52*
	58	60	65	*61*		46	44	46	*45*		51	51	54	*52*
	58	57	73	*63*		47	41	48	*45*		52	50	52	*51*
	53	69	58	*57*		47	42	35	*45*		49	50	53	*48*
	52	52	57	*54*		43	45	35	*44*		47	46	50	*48*
	49	59	58	*55*		42	42	44	*43*		44	48	50	*47*
	50	49	54	*51*		44	41	45	*43*		55	50	48	*48*
	51	50	56	*52*		46	40	42	*43*		43	49	49	*47*
	51	47	60	*53*		48	37	41	*41*		44	46	50	*47*
	49	49	62	*53*		43	40	44	*42*		42	44	51	*46*
	49	51	53	*51*		41	41	62	*41*		42	41	46	*43*
	50	48	52	*50*		44	39	40	*41*		40	40	44	*41*
	50	43	50	*48*		42	36	41	*40*		41	38	42	*40*
	50	44	51	*48*		40	38	42	*40*		40	38	44	*41*
	47	46	51	*48*	B.	58	60	70	*63*		39	39	42	*40*
	46	44	49	*48*		56	55	59	*57*	C.	56	54	49	*53*
	47	46	49	*47*		56	54	60	*57*					
	46	44	51	*44*		54	54	59	*56*					

Table VI. shows the results of the three new subjects who practiced at their own speed on the color series five times each day. The perpendicular columns under each name represent the time in seconds for the successive practices. Section A represents the first arrangement of colors and keys, section B shows the results of the keys changed, and C of the series changed. The last column in italics shows the average curve. The results of this experiment are shown by Plate II., 1 and 2.

Table VII., page 24, represents the *fifth experiment* on the typewriter. Two short-letter series of twenty each were made up of six different letters. The third row on the typewriter, containing six keys covered with blank caps, was used. Immediately in front of this row in a stationary position was placed a strip of white cardboard upon which were printed the six letters of this series at distances apart, so that each letter was directly in front of one of the blank keys. On the opposite side of this card was placed the same group of letters, but in different

order. If we name the two series (between the screen) series I. and II., the two arrangements of the letters on the cardboard in front of the keys arrangements I. and II., the orders practiced were as follows:

A	Series I.,	Arrangement I.
B	" II.,	" I.
C	" II.,	" II.
D	" I.,	" II.
E	" I.,	" I.

This experiment consisted of one continuous practice, except that a short rest was taken at the middle of each set of ten. Each of these orders was practiced ten times and the figures in the vertical columns show the time (taken by the stop-watch) of the successive practices. The last column in italics shows the average.

TABLE VII.

	Me.	Mi.	Cl.	Av.		Me.	Mi.	Cl.	Av.		Me.	Mi.	Cl.	Av.
A.	28	30	31	*29*	B.	25	27	28	*27*	C.	34	30	36	*33*
	25	28	32	*28*		24	24	26	*25*		26	24	33	*27*
	22	24	30	*25*		24	25	25	*25*		24	25	30	*26*
	20	22	25	*22*		22	22	25	*23*		25	22	30	*26*
	21	22	26	*23*		22	22	22	*22*		24	23	25	*24*
	22	20	23	*22*		22	20	24	*22*		22	22	25	*23*
	21	21	22	*21*		21	21	21	*21*		24	22	23	*23*
	22	20	22	*21*		19	20	21	*20*		22	20	21	*21*
	21	22	22	*22*		19	18	20	*19*		21	21	21	*21*
	21	20	21	*21*		20	19	21	*20*		22	20	21	*21*

	Me.	Mi.	Cl.	Av.		Me.	Mi.	Cl.	Av.
D.	27	26	29	*27*	E.	22	24	26	*24*
	24	23	25	*24*		20	22	25	*22*
	23	24	24	*24*		21	19	23	*21*
	25	22	23	*23*		17	20	24	*20*
	23	23	23	*23*		20	19	25	*21*
	23	21	20	*21*		21	20	22	*21*
	22	31	21	*21*		18	18	21	*19*
	24	22	20	*22*		18	17	21	*18*
	22	19	19	*20*		19	19	20	*19*
	19	20	19	*19*		18	18	19	*18*

In Table VII., each of three perpendicular columns headed by the name of the subject represents the results of that subject. Beginning above, the first section of the table (A) represents the results of practicing series I. and arrangement I. together ten times. Section B represents the results when substituting series II. for I., etc., as shown above.

The *sixth experiment*, Table VIII., shows the result of practicing twenty series of letters and figures, composed of six dif-

ferent letters or figures each (no two letters or figures being alike in any two series). Each series consisted of a group of fifty-five. These twenty series were placed on the roller in a similar manner to those already described. On twenty strips of cardboard were printed the respective letters or figures of the twenty series, so that when they were placed in position in front of the blank keys one letter was directly in front of each key. Three new subjects were procured, and one of the old subjects, Sm. was the fourth. The experiment shows a decided practice effect for all the subjects, although no two of the twenty series were alike. It cannot be argued that the practice effect was due to getting adjusted to the machine, or to getting adjusted to a common element in all these series, for Sm., who had many previous practices in the other experiments, showed almost as much practice effect as the new subjects.

TABLE VIII.

Wr.	Fa.	Js.	Sm.	Av.	Mv.	Wr.	Fa.	Js.	Sm.	Av.	Mv.
62	95	71.5	65	*74*	*11*	59	85	62	60	*66.5*	*9*
61	93	68	65	*72*	*8*	59	85	70	57	*68*	*10*
62	88	66	63	*70*	*10*	58	87	65	56	*66.5*	*12.5*
60	91	63	64	*70*	*11*	57	84	64	58	*66*	*9*
60	87	63	61	*68*	*12*	55	86	61	58	*65*	*10.5*
55	88	66	60	*67*	*10.5*	54	87	61	57	*65*	*11*
56	91	64	60	*68*	*7*	52	85	57	56	*62.5*	*11*
53	90	61	62	*66.5*	*12*	52	87	60	55	*63.5*	*11.5*
57	85	67	65	*66*	*45*	53	84	62	58	*64*	*10*
60	88	58	62	*67*	*10.5*	52	84	58	56	*62.5*	*10.5*

Table VIII. shows the results of the sixth experiment. The figures in the vertical columns show the number of seconds it took to run over the successive series. The column in italics shows the average time it took all the subjects, and the last column the mean variation. These series were not gone over by any two of the subjects in the same order. This was done to be sure that all the series, if not alike difficult, would be distributed by chance.

The *seventh and last experiment* with the typewriter also represents one continuous practice. Eight series of letters of twenty in a series, with the same letters in two series, were made and put on the roller behind the screen. The first series contained but two letters, arbitrarily arranged, the second series contained the same letters, but differently arranged. These two series we shall refer to as series D and D′. The next two series were made up of three letters different from those of the first two series, and similarly arranged in serial order. These are series N and

N′. Likewise the fifth and sixth series and the seventh and eighth were arranged respectively from four and five different letters. These are series M and M′, and series O and O′. The blank keys in the third row of the machine were used. On eight strips of cardboard were put the letters of the respective series at distances to suit the keys. These letters were arranged in two different orders for each series. These orders I shall refer to respectively as arrangements D and D′, N and N′, M and M′, and O and O′ to correspond with the series.

An experiment consisted in practicing through the series in the following orders, repeating each order ten times.

Two-letter series.	1.	Series D	Arrangement D
	2.	" D′	" D
	3.	" D′	" D′
Three-letter series.	1.	" N	" N
	2.	" N′	" N
	3.	" N′	" N′
Four-letter series.	1.	" M	" M
	2.	" M′	" M
	3.	" M′	" M′
Five-letter series.	1.	" O	" O
	2.	" O′	" O·
	3.	" O′	" O′

A short rest was taken at the middle of each of the orders practiced.

Table IX.

Error.

Rate.	Ba.	Me.	Mi.	Sm.	Av.	Mv.
66	17	22	27	18	*21*	*3.5*
72	26	28	33	29	*29*	*2*
80	35	37	41	35	*37*	*2*
88	36	36	46	38	*39*	*3.5*
96	37	40	45	42	*41*	*2.5*
104	39	43	50	40	*43*	*3.5*
Time:	69	66	71	68	*69*	*15*

Table IX. shows the results of a test experiment on the typewriter, made for the purpose of filling in the curves on Plate I. (dotted lines). Different series of fifty-five made up of six different letters, one series for each rate. The experiment was made in the same manner as experiment V., but with the beat of the metronome instead of taking the subject's most rapid time. The practice at each different rate was on a different series. The averages for all the subjects at each rate were the numbers used in completing the curves in Plate I. These values are not the same as we would have gotten [judging from the results of experiment V.] had we made the very first experiment at the rate of one or other of the curves, instead of beginning at the lowest rate and getting partly adjusted until we get to the more rapid rates.

Section I. shows the decrease in the number of seconds required to run over the series with the increasing number of practices. Section II. shows the interference and rate of readjustment when the series are changed, and Section III. the interference when the letters on the keys are interchanged. This table shows that the interference is greatest when the greatest number of reactions are involved, and greater when the keys than when the series are changed.

Table X.

	2				3				4				5			
	Mi.	Me.	Sm.	Av.	Mi.	Me.	Sm.	Av.	Mi.	Me.	Sm.	Av.	Mi.	Me.	Sm.	Av.
I.	21	20	19	*20*	27	24	22	*24*	26	27	26	*26*	32	31	33	*31*
	19	19	17	*18*	25	20	20	*22*	26	22	24	*24*	32	24	25	*27*
	21	19	17	*19*	23	19	18	*20*	24	21	24	*23*	29	23	26	*26*
	19	18	16	*18*	23	20	19	*21*	23	22	20	*22*	27	24	24	*25*
	22	18	16	*19*	24	18	18	*20*	22	22	21	*22*	26	22	22	*23*
	20	20	17	*19*	21	18	18	*19*	20	20	20	*20*	26	20	20	*22*
	20	18	16	*18*	22	16	15	*18*	20	21	20	*20*	24	21	20	*22*
	19	18	15	*17*	20	17	17	*18*	20	19	18	*19*	25	20	21	*22*
	17	17	16	*17*	18	17	15	*17*	19	20	18	*19*	22	19	18	*20*
	17	17	15	*16*	17	16	14	*16*	19	20	17	*19*	20	19	18	*19*
II.	22	24	23	*23*	24	21	23	*23*	23	23	24	*23*	25	23	24	*24*
	19	22	20	*20*	23	20	22	*22*	23	22	21	*22*	26	21	24	*24*
	18	21	18	*19*	21	19	20	*20*	22	20	22	*21*	24	22	21	*22*
	19	21	18	*19*	20	20	20	*20*	20	21	11	*20*	20	21	20	*20*
	21	19	18	*19*	20	20	19	*20*	19	19	18	*19*	21	21	20	*21*
	21	20	16	*19*	21	19	20	*20*	19	20	18	*19*	20	20	19	*20*
	17	16	17	*17*	20	16	18	*18*	18	21	16	*18*	19	19	19	*19*
	16	17	16	*17*	18	18	17	*18*	19	19	17	*18*	20	19	20	*20*
	17	14	15	*15*	17	16	15	*16*	18	18	16	*17*	18	20	18	*19*
	15	14	13	*14*	18	16	16	*17*	18	19	17	*18*	18	19	17	*18*
III.	22	24	24	*24*	28	28	26	*27*	29	31	27	*29*	30	32	28	*30*
	21	20	22	*20*	25	24	21	*23*	25	27	28	*27*	30	29	25	*28*
	20	20	19	*20*	25	23	23	*24*	23	24	26	*24*	27	28	26	*27*
	21	19	18	*19*	24	22	20	*22*	24	23	22	*23*	24	25	24	*24*
	19	18	18	*18*	20	21	20	*20*	20	23	21	*21*	25	23	20	*23*
	20	17	16	*18*	21	20	18	*20*	21	22	21	*21*	22	24	21	*22*
	18	18	18	*18*	19	21	18	*19*	20	21	19	*20*	23	21	21	*22*
	19	16	17	*17*	20	18	17	*19*	21	18	19	*19*	22	23	19	*21*
	17	15	15	*15*	19	19	16	*18*	19	19	17	*18*	19	20	20	*20*
	16	15	14	*15*	19	17	17	*18*	20	18	18	*18*	20	20	19	*20*

Table X. shows the results of three subjects and their average. The perpendicular columns below each name show the results of that subject in the 2, 3, 4 and 5 letter series. In Section I., when first order was practiced, in II., when the series were changed, and, III., when the keys were changed.

Other experiments besides those with the typewriter, relating to the motor side of association, were made. These I shall now describe.

The first of these consisted in taking daily records, for twenty days, by means of a stop-watch, of the time required to repeat the alphabet from memory. Each day's experiment was as follows: First, the alphabet was repeated as rapidly as possible forward; secondly, the letter *n* was intercepted between each of the letters; thirdly, the alphabet was repeated as rap idly as possible backward; and lastly, the alphabet was repeated backward intercepting *n* between each of the letters. At the end of twenty practices in each order the subject repeated the alphabet, first, forward, intercepting, instead of *n*, the letter *x* repeating three times; secondly, intercepting *r* and repeating three times; then lastly, repeating backward, and in like manner intercepting *x* and *r* and repeating three times.

TABLE XI.

A B C	Me.	2.7	2.6	2.6	2.7	2.7	2.7	2.7	2.7	2.7	2.5	2.4	2.4	2.2	2.3	2.5	2.4	1.7
	Ba.	3.5	3.4	3.2	2.9	2.7	2.6	2.5	2.5	2.6	2.6	2.5	2.5	2.5	2.4	2.5	2.5	2.5
	Mi.	2.5	2.7	2.5	2.7	2.5	2.5	2.5	2.7	2.7	2.6	2.5	2.4	2.5	2.5	2.4	2.4	2.5
	Av.	*2.9*	*2.9*	*2.8*	*2.8*	*2.6*	*2.6*	*2.6*	*2.6*	*2.7*	*2.6*	*2.5*	*2.4*	*2.4*	*2.4*	*2.5*	*2.4*	*2.2*
$A_n B_n C_n$	Me.	25	14	11	10	10	11	10	9	10	7	8	7	7	6.5	6.7	7	7.5
	Ba.	27	18	13	13	11	12	12	8	8	7.5	7	6.5	6	5.7	6	6.2	6.5
	Mi.	20	14	13	10	9	8.5	11	8.5	8	8	5.5	6	6	5.5	5.5	6	6
	Av.	*24*	*15*	*12*	*11*	*10*	*11*	*11*	*8.5*	*8.5*	*7.5*	*6*	*6.5*	*6.3*	*5.9*	*6.1*	*6.4*	*6.8*
Z Y X	Me.	35	27	18	19	17	15	16	16	20	14	25	11	15	16	10	10	9
	Ba.	32	25	16	14	12	9	10	7.5	6	7	5	7.5	4.5	3.5	2.7	2.5	2.5
	Mi.	27	21	17	18	15	13	16	10	12	14	9.5	9.5	10	7	5.5	5	4
	Av.	*32*	*24*	*17*	*17*	*15*	*12*	*14*	*11.5*	*13*	*12*	*9*	*9.5*	*10*	*9*	*6*	*6*	*5*
$Z_n Y_n X_n$	Me.	43	35	27	20	19	20	25	19	24	16	18	7.5	16	14	16	16	14
	Ba.	56	44	35	24	16	9.5	9.5	13	10	8.5	8.5	8	7	10	10	8	8
	Mi.	35	33	34	24	18	17	15	14	13	17	14	10	9	13	10	8	9
	Av.	*45*	*37*	*32*	*23*	*18*	*18*	*17*	*15*	*16*	*14*	*14*	*9*	*9*	*12*	*11*	*11*	*10*

$A_x B_x C_x$	Me.	8	7	7	7
	Ba.	9	9	8	7
	Mi.	16	13	12	13

$A_r B_r C_r$	12	11	12	8	7
	12	14	9	8	7
	18	14	10	11	10

$Z_x Y_x X_x$	25	26	20	18
	27	19	17	15
	21	19	18	19

Table XI. shows the results in number of seconds required for these experiments. The upper three horizontal columns in each of the sections show the results of three subjects whose names appear in the margin, and the fourth column the average. These averages are plotted in Plate II., 3. The table shows the regular practice curve. The fifth part of the table shows the same as experiment V., Table VIII., that one kind of practice helps us in another kind.

The second general experiment consisted in a test of the improvement of rate of movement with practice. It was also to show the effect of interference when some modification of the figure practiced was made. On a sheet of paper on which was printed a figure 10 cm. square, containing one hundred squares 1 cm. square, making ten rows of ten squares each, the subject drew curves as rapidly as possible in each row of squares. These curves were composed of loops, some turned up and some down, one loop in each square. Each sheet of paper contained ten curves. The time it required to fill up one sheet of curves was determined by a stop-watch. Each day's practice consisted in filling up six sheets. On the last sheet the curve was slightly modified in two places by interchanging two loops that were turned in opposite directions.

TABLE XII.

Ba.	Me.	Mi.	Ba.	Me.	Mi.	Ba.	Me.	Ba.	Me.
61	69	92	42	55	43	35	45	34	38
51	63	65	41	57	44	35	47	33	35
45	60	52	*44*	*62*	*48*	33	42	*33*	*36*
51	58	55	41	53	46	35	40	35	34
44	59	51	37	50	42	33	42	*32*	*34*
49	*70*	*56*	38	50	44	*36*	*44*	32	34
41	*56*	*44*	36	46	43	34	43		
39	52	43	37	44	43	35	40		
40	57	39	*62*	*51*	*47*	33	40		

Table XII. shows the results of this experiment. The perpendicular columns show the results of each subject whose name is printed above. The figures in italics show the interference when figure is modified after five practices. The time it took the subject to write each curve was also determined as well as possible by the attendant. These results are not represented in the table because they are not absolutely accurate, but they show that in each paper the time required to produce the curve decreased very rapidly at first, less rapidly respectively in the second and third, and in the fifth practice each curve began to take, on the average, longer, due to fatigue. In the sixth sheet when the curve was modified the first curve took considerably longer than any of the succeeding. The adjustment to the new curve was very rapid. If we compare the time it took to produce the practiced curve the last time with that of the modified curve the first time, the second is more than twice the first. This is due to pauses made while the curve is being produced.

The next experiment was to get a curve for the rate of perception. On a sheet of paper were printed 508 letters in thirteen lines containing one hundred *a*'s arbitrarily arranged. The test consisted in seeing how long, from day to day, it would take the subject to mark all the *a*'s. Each day's practice consisted in marking from five to seven papers, sometimes marking the last few backwards.

Table XIII.

Ba.	Me.	Mi.	Ba.	Me.	Mi.	Ba.	Me.	Mi.	Ba.	Me.	Mi.
100	68	122	72	*58*	*90*	*70*	*55*	73	*58*		*65*
83	62	92	71	59	*88*	73	55	71	*54*		**90**
85	61	82	71	52	71	67	53	69	62		
77	56	86	66	55	68	65	49	*72*	60		
70	54	81	70	49	62	71	56	*70*	57		
71	*62*	81	67	*61*	62	68	49	*71*	90		
69	*61*	74	66	*65*	66	62	48	73	*57*		
70	55	79	62	58	*82*	66	**77**	68	**88**		
71	53	77	65	52	*79*	59	**74**	62			
71	54	77	*84*	47	*71*	60	**70**	*65*			
76	*64*	*93*	*72*	*55*	68	*61*	**62**	**94**			

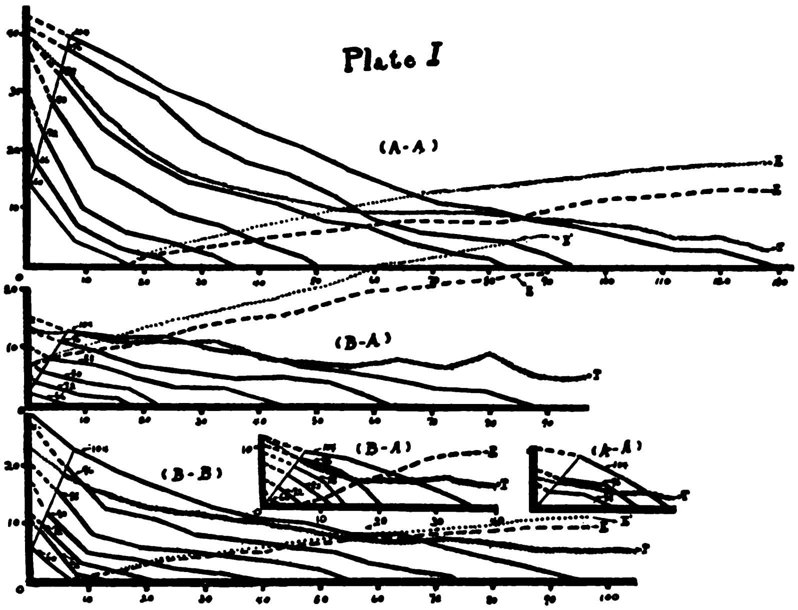
Table XIII. shows the results of the A experiment. The figures in italics show the increase in time required when they were marked backward, contrary to the accustomed order. The letters in black show the interference when only every other *a* was marked.

The next test is one to get the curve for the improvement of accuracy of movement with practice. The test was to determine how many shot out of sixty the subject could put at a distance of two feet into a wine glass.

Table XIV.

Ba.	Me.	Mi.	Sm.	*Av.*	Ba.	Me.	Mi.	Sm.	*Av.*
28	37	43	45	*38*	13	32	24	27	*24*
24	35	41	41	*35*	11	26	24	26	*22*
17	34	30	36	*29*	9	27	25	26	*22*
20	41	29	39	*32*	7	32	21	20	*20*
12	33	28	34	*27*	6	26	20	22	*19*
20	28	26	30	*26*	6	20	19	28	*18*
17	22	23	30	*23*	5	22	20	27	*18*
15	24	24	34	*24*	4	36	20	20	*20*
13	28	25	37	*24*	5	24	17	19	*16*
17	32	22	31	*25*	4	23	17	18	*15*

Table XIV. shows the results of the successive daily practices in throwing shots into a cup. The figures in the perpendicular columns show how many out of sixty in each practice the subject, whose name heads the column, got into the cup. One practice was made each day, and the last column, in italics, shows the average number of shots put in each of the successive practices.



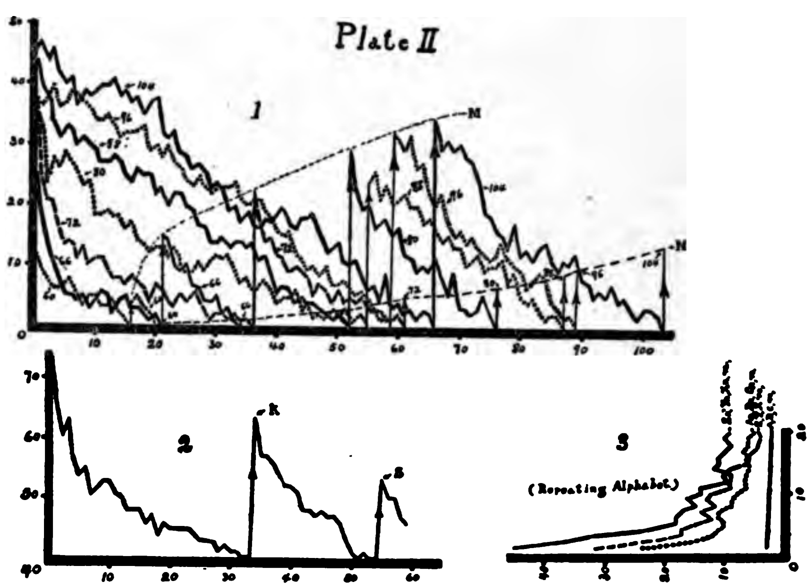
DESCRIPTION OF PLATE I.

In the curves on this plate the ordinates show the number of mistakes in the error curves, represented by the smooth lines, and the rate, represented by the feathered line. The zero abscissa line is the line of no mistakes in the error curves and the thirty seconds line in the rate curve. Since the least time in which any of the subjects could run through the series without an error was thirty seconds, this time was considered as the physiological limit, and any rate slower than thirty seconds was represented by so many points above the zero abscissa. In this way the time curve and the error curves were made closely comparable. The abscissas represent the numbers of practices, each practice representing a point in advance of the previous practice on the abscissa. The seven smooth curves represent the mean error curves for all the subjects at the seven rates practiced. The lower curve represents the curve for the slower rate, *i. e.*, 60 associations per minute and each of the succeeding curves respectively a more rapid time, the upper curve representing the most rapid rate, *i. e.*, 104 associations per minute. The daily practices consisted in running through the series successively eight times from the slowest to the most rapid rate, and concluding by taking the subject's time, which is represented by the feathered curve. The errors at each rate for each day's practices were marked on the coordinate paper in the following manner: The number of errors at the first (slowest) rate of one day's practices was marked at their respective place one point to the right of the last rate of the previous day's practices. Each succeeding rate, in order, was marked one place to the right of the preceding at its respective place on the ordinate, so as to represent the number of errors of that rate. This makes the error points at each rate eight places apart on the abscissa. These points

of each rate were connected by straight lines to form the curve for each rate. The dash lines at the beginning of each curve represent the probable form of the curves, determined by test experiments if the first practice had been at the rate of that curve, instead of getting partly adjusted by preliminary experiments at lower rates.

The curves of (*A–A*) represent the first series of practices, which were continued until all the errors were eliminated at all the rates. (*B–A*) shows the interference and the number of practices at each of the rates, practicing through in the same order of rates when the serial order of stimuli was changed, (*B–B*) when the keys were changed, (*B–A*) when the keys were changed back again to their former positions and (*A–A*) when the original order was again referred to.

The dash line *E* represents the interference which took place at the different rates when the order was changed, and the dotted line *E′* the interference which would have taken place if, when the series or keys were changed, the first practice had been at the rate of each of the curves instead of, as usual, going through the series of rates and thus getting partly adjusted to the new arrangement before the first practice at, *e. g.*, 96 or 104 per minute. The interference lines *E* and *E′* are formed by connecting the points representing the number of errors which occurred or would have occurred at each rate when the order was changed, these error points being placed on the ordinates respectively passing through the points where the curves at each rate reached zero.



DESCRIPTION OF PLATE II.

The curves in Plate II., first figure, represent the results in errors obtained from seven subjects, each practiced at one of the rates throughout. The subject practiced five times a day at his rate until he made no more errors, then the

keys were changed and the experiment was continued until the errors were again eliminated, when the color series was changed and the interference at that rate noted. This experiment succeeded that represented by Plate I., and four of the subjects, those practicing at the 72, 88, 96, and 104 rates, had served in the first experiment, on a different series. Their curves show that they learned more rapidly than the other new subjects, their previous practices helping them to get adjusted more rapidly.

The light dash line *M* shows the curve of interference when the keys were changed and the heavy dash line *N* the interference when the series were changed, these interference curves being formed by connecting the error points of the first practice at each of the rates when a change in the order is made.

The second figure of this plate represents the time curve. This curve is the mean time curve of the three new subjects practicing through a series of fifty-five, five times each day for seven days, when they did it at an average of forty seconds. Then the keys were changed and the practice was continued until the average was again forty seconds, which required five days' practice, then the series was changed and the increase in time noted. In all these experiments the subject made the usual daily practices just before and about two minutes after the change of series. According to Bergström's results the interference would not have been so great if the interference practices had been made the day after the last practice of the old order.

The third figure represents the mean curves of four subjects in the alphabet experiments; the ordinates represent the time in seconds.

Table XV.

B.	C.	S.	F.	E.	S.	C.	E.	G.	M.	D.
5 yr.	4 yr.	3 yr.	2 yr.	2 yr.	2 yr.	2 yr.	2 yr.	1 yr.	2 yr.	2 yr.
2.3	2.5	4.2	4.1	5.3	3.5	5.1	4	6.2	5.7	6
2	2.2	1.8	4.2	4.1	2.2	3.2	2.8	4.3	4.7	4
2.1	1.7	1.7	2.6	3.2	1.5	2.7	1.7	4.1	3.6	3.1
1	1.2	1.2	2	2.9	1.3	1.6	1.3	2.5	3	3.2
1	1	1.2	2.7		1.2	1.1	1.2	2.7	1.5	1.9
	1	1.5	2.4		1.1	1.3	1.3	1.9	1.1	1.6
		1	1.9		1	1	1	1.3	1	1.2
		1	1.5		1	1	1	1	1	1

Table XV. shows the results of the ten children tested. The perpendicular columns headed by name and age of the child whose results that column represents show the influence of practice on discrimination. The figures, the successive practices being represented downward in the column, show the average number of trials each child made with each block in the successive trials. If the numbers be multiplied by ten we have the total number of trials in each experiment required by each child to get all the blocks in. The board was kept cleared of blocks, so that the conditions as far as possible were kept constant throughout the experiment. This experiment shows that the child learns to discriminate slowly. Likes and differences are not always immediately perceived, but that accuracy of discrimination also follows the law of the practice curves. It is evident from these results that the child learns to discriminate in about the same way as the animal.[1]

[1] 'Animal Intelligence,' Thorndike, Psychological Review, Monograph Supplement.

The last experiment was on children of from two to five years of age. The purpose of it was to determine the rate of improvement of discrimination with practice. The method used to make this test was to see how many trials were necessary for the child to put ten blocks of various shapes into their respective holes in a board. The blocks and their holes were all about the same size, and no block could be put into any but its own hole. Each block had a handle to it so that the child would always get the right side of the block on the board.

Other experiments to test the relation between thought and movement, such as saying as rapidly as possible 1, 1, 1, . . . while thinking a, b, c, . . . , putting oneself in a certain bodily attitude to see whether some reminiscence usually accompanying that attitude would come up, trying to think upper then lower *do* without adjusting the vocal organs, etc., were made, but these experiments, since the results cannot be tabulated, will be discussed in the next section of this article.

Besides the experiments so far described I have made another series of tests similar to those on the typewriter but with cards. These experiments were partly a duplication of those made by Bergström in 1892.[1] Since his results did not seem to compare with mine, I thought it advisable to duplicate some of them in order to try to find out the reason for the conflicting results.

The cards I used were similar to his, having ten pictures and eight cards of each picture. I used only one interval, the one, minute interval between the first and second dealings. In the second dealing the cards were placed in a different order and were dealt in different positions. I found considerable interference but not nearly so much as Bergström. I then tried to find how much of the interference is probably due to suggestion. A number of subjects were tested who did not know Bergström's results nor the object of this experiment. They were asked to determine introspectively how much easier it goes the second time than the first. The results were as follows:

1. 19 subjects influenced by suggestion: *first dealing*, 89^6 *M. V.* ± 9; *second dealing*, 87^5*M. V.* ± 13.

[1] 'Experiments upon Physiological Memory by Means of the Interference of Association,' *American Journal of Psychology*, Vol. V., pp. 356–372.

2. 21 subjects familiar with Bergström's results: *first dealing*, 79^6 *M. V.* $\pm$ *9.8; second dealing*, *87 M. V.* $\pm$ *10.7.*

1 and 2. 40 total number of subjects: *first dealing*, *84.2 M. V.* $\pm 9^6$; *second dealing*, *87.4 M. V.* $\pm$ *11.8.*

In 1 the second dealing averaged two seconds less than the first.

In 2, when the conditions were similar to those under which his experiments were made, the second averaged 7.5 seconds more than the first dealing.

Bergström's results show[1] that in the first dealing the average time required was 84.15 seconds and the second 96.34 seconds, making the second 12.19 seconds longer than the first.

I found slight interference on the typewriter also when practicing one series once and then changing the keys and practicing a different serial order.

The question came up whether the interference becomes greater with the number of practices—*i. e.*, does a habit which has been made permanent with many practices offer more resistance to displacement by a different habit than one formed by only one or a few practices? To test this the experiments reported in Table XVI. were made. From the eighty cards used in the former experiment forty-two were taken with six different pictures and seven of each picture. These cards were dealt as rapidly as possible in one order and immediately afterward, at one minute interval, in a different order and the interference noted in length of time the second required over the first dealing. Then on the typewriter the subject ran as rapidly as possible over a series of six different colors forty-two in the series reacting on six different keys, and then changing the keys and the serial order of colors and repeating after one minute interval. Then the cards were again dealt in the same order and position, on the table, ten times with intervening intervals of one minute, and then changing back to the second order and repeating once, and then doing the same thing on the typewriter. The results show (Table XVI.) that the difference in time required, between one dealing and another requiring antagonistic reactions, becomes slightly greater

[1] See Table IV., page 362, *op. cit.*

with the number of practices of one order before the other is taken up, but this increasing difference is due to the increase in speed gained in the practice of the first order, and not to interference. The results show that it takes less time to make the associations in the second order after practicing the first order ten times than it does after practicing it only once.

TABLE XVI.

Name.	Time in seconds required for first practice.		Time in seconds required for different order immediately afterward.		Time required in 10th practice of the same order.		Time required when change is made after 10 practices of the same order.	
	Type-writer.	Cards.	Type-writer.	Cards.	Type-writer.	Cards.	Type-writer.	Cards.
Ba.	38^{5} 39^{5}	38^{5} 40	41	39^{5}	34^{5}	30^{5}	39	39
Sm.	35 34	33 34^{5}	36	37^{5}	29	26	34	33
Jn.	47 46	39^{5} 41	53	48	40	34^{5}	48	44
Mi.	42 38	35 35^{5}	49^{5}	38^{5}	32	27	42	34
Hm.	42 43^{5}	37 34	50^{5}	41	38	26	42^{5}	36
Js.	45 47	33^{5} 34^{5}	53	37^{5}	30	25	46	35
Ts.	46 44	45 42	47	52	37	37	46	44
Fn.		34 35		38^{5}		23		34
Hn.	51 49^{5}	40^{5} 36^{5}	58^{5}	41	34	30	50^{5}	39
Av.	43	37^{5}	48.1	41.1	$34.^{8}$	28^{6}	43^{5}	36^{6}
Av. Var.	$\pm$ 4.3	$\pm$ 3	$\pm$ 5.4	$\pm$ 3.5	$\pm$ 3.4	$\pm$ 4.1	$\pm$ 4.3	$\pm$ 3.5

Table XVI. shows the time required to make 42 association reactions on the typewriter and in dealing the cards. The first two perpendicular columns of figures show the time in seconds required to go through, for the first time, the series of 42 reactions on six keys of the typewriter, or to deal out 42 cards into six different positions. The second two columns show the time required immediately after when the keys were interchanged and the cards put into different positions. The third two columns show the number of seconds required to make the tenth practice in the same order. The last two columns show the time required to run through the series in a new order immediately after ten practices in the same order have been made.

I have continued this experiment for twenty, thirty and forty practices in one order before the other order was practiced, and found that the more practice in one order one makes the less time it takes to run over a different order. The table shows the results of this experiment.

TABLE XVII.

	Typew.	Cards.		Typew.	Cards.		Typew.	Cards.
First practice.	38^5	38^5				Immed. after in different order.	41	39^5
First practice.	39^5	40	Time required in 10th practice of same order.	34^5	30^5	Time required after changing to new order after 10 practices.	39	39
First practice.	37	41	Time required in 20th practice of same order.	29	25	Time required after changing to new order after 20 practices.	36	37
First practice.	39	37	Time required for 30th practice of same order.	24	23	Time required after changing to new order after 30 practices.	34	32
First practice.	36	38	Time required for 30th practice of same order.	21	20	Time required after changing to new order after 30 practices.	32^5	31^5

I also made the same experiment with one subject on the full series on the typewriter (Series A and B, etc., as described on pages 15–16). The following table shows the results:

TABLE XVIII.

(Subject Bn.)

First practice.	68^5			Immediately after in different order of keys.	77
2 days afterward, same order.	69	Time required in 10th practice of same order.	65	Immediately after 10th practice when order of keys was changed.	73^5
5 days afterward, same order.	63	Time required in 20th practice of same order.	58^5	Immediately after 20th practice when order of keys was changed.	68^5
2 days afterward, series B.	67	Time required in 30th practice of same order.	54	Immediately after 30th practice, key arrangement C.	66
4 days later, key arrangem'nt C.	65^5	Time required in 30th practice of same order.	50	Immediately after 40th practice, key arrangement D.	64

The same experiment was also made using the same series with a different subject, when the rate was kept constant at 104 with the beat of the metronome, and the number of errors were kept account of, with the following result ·

TABLE XIX.

(Subject Ba.)

First practice.		Immediately afterward in different order of keys.
39		47
3 days afterward, same order.	Same order. Time required in 10th practice.	Immediately after 10th practice, order of keys changed.
39	31	45
2 days afterward, series B.	Time required in 20th practice of same order, series B.	After 20th practice, when keys were changed to series C.
40	26	40
3 days later, series C.	Time required in 30th practice of C.	After 30 practices of series C, when changed to series D.
38	22	38

I made also another experiment with the cards comparable to the fifth experiment on the typewriter, page 23, the results of which are shown by Table VIII. and the mean curve of which results is shown on Plate III. (4), *i. e.*, I used the eighty cards and sorted them twenty times, each time having the cards arranged in different order in the deck and also on the table upon which they were dealt; each kind of card in each sorting was put into a different position. Two subjects were tested in this experiment, and curve 3, Plate III., shows the results.

Introspections were taken in all these experiments, but these will be given account of in our discussion and interpretation of results.

SUMMARY OF RESULTS.

The results of the experiments described can be summed up in the few following statements:

1. By practicing a particular reaction, or series of reactions, to a certain stimulus, or series of stimuli, until these responses become automatic, and then associating the same response, or series of responses, with a different stimulus, or series of stimuli, or a different order of responses with the same set of stimuli until the new order becomes automatic, and then again returning to the first order, going from one order to the other every time the order practiced becomes automatic, the time becomes continually less for the subsequent adjustments until, finally, after a sufficient number of alternating adjustment practices, either

order can be responded automatically, one needing but voluntarily to start the response impulse in one direction or the other, and the whole series of responses proceed as though that were the only order ever acquired. These results show that the neural disposition of an old habit does not vanish when a new one is formed which excludes the old. Some residue remains in the cells once associated, so that with a very few practices a definite connection can again be established.

2. In practicing a series of responses with a series of stimuli until they became automatic, when the time is kept constant by means of a metronome, the decrease in the number of errors follows the law of the practice curve.

3. The greater the number of possible reactions the slower the rate of adjustment and the later the time at which no errors will be made.

4. There are less errors made and it takes fewer practices to eliminate them at the slower rates than at the faster.

5. When the errors are kept constant, *i. e.*, at zero, the time required from day to day is constantly reduced by practice until the physiological limit is reached, or at least approached.

✓ 6. If after the responses have been repeated many times to a certain serial order of stimuli, and then either the order of stimuli, the order of stimuli to responses, or both, are changed, there will be a considerable rise in the practice curve, of errors when the time is kept constant, or of increased time when the errors are kept constant. The rise in the practice curve being larger when the particular responses to particular stimuli (sensori-motor connections) are altered, than when a change in the serial order of stimuli (physiologically speaking, motor-motor or sensori-sensory connections) is made. The rise is still greater when both the sensori-motor, and sensori-sensory, motor-motor connections are changed.

In none of these three cases, however, when, in one order, a number of practices sufficient to approach the proficiency limit were made, did the curve rise as high, when the change was made, as it started in the first practice.

7. There may be such a thing as interference when a change is made upon a few practices, but the rise in the practice curve

seems to be due to the learning of the new order, and not to interference.[1]

Discussion and Interpretation of Results.

Tables I., II., III. and IV., being a summary of the results of the first two experiments, show, first, the rate at which a series of stimuli can be reacted to by a series of responses, and how this rate can be constantly increased by successive practices; second, that any rate faster than the rate at which the subject can just make all the reactions correctly results in a certain number of errors, and that the more rapid the rate with the same amount of practice, the greater will be the number of errors, until a certain limit is reached beyond which the laws of chance operate, and that the number of errors at any given rate is constantly decreased with continued practice until all the errors at that rate are eliminated. We have found by trial that the number of errors at any rate above one hundred and four per minute for the average subject without previous practice, is entirely dependent on chance. One hundred and four per minute was therefore taken as the upper limit for speed of association in these experiments.

The average number of errors at this rate for the four subjects tested, in the first practice, was 40, and it took these four subjects an average of 129 practices to eliminate all the errors. It took on an average 62 seconds, after seven practices, at the subject's own rate, without making any errors, to run through the series, and on the one hundred and twenty-eighth practice the average was only 37.5 seconds at the subject's own rate without errors.

When the color series was changed, *i. e.*, color series B substituted for A, there were 13 errors, and it took 86 practices to eliminate the errors at the 104 per minute rate. In the eighth practice of this order at the subject's own rate, it took an average of 43 seconds to complete the series. At the end of this read-

[1] I wish here to express my obligation to those who have given me their assistance in this research, Professors Cattell, Farrand and Thorndike, for their suggestions, and Messrs. Miner and Messenger for their daily services as subjects, and to all others who acted in a similar capacity.

justment practice, *i. e.*, when the subject could again run over the series at the 104 rate (the 86th practice) without making errors, it took an average of 35 seconds, at the subject's own time without an error, to make the series.

When now the keys were interchanged, *i. e.*, when arrangement B was substituted for arrangement A, there were 23 errors at the 104 per minute rate, and it took 98 practices until at this, the most rapid rate, there were no more errors. See Tables II. and IV., pp. 18–20.

When color series A was again substituted for B it took 37 seconds in the eighth practice after the change to run through the series at the subject's own rate without errors, and in the forty-eighth practice, when the readjustment was completed, it took 33.5 seconds at the subject's own rate. In the seventh practice of this order, at the 104 rate, there were 9 errors, and it took 36 practices to eliminate them.

When now again the combination as first practiced — *i. e.*, series A, arrangement A — was resorted to in the seventh practice, there was an average of 9 errors at the 104 per minute rate, and it required 22 practices to eliminate the errors at this rate. The time it required to run through this series on the eighth practice was 34 seconds, and on the twenty-fourth practice 31 seconds.

The order followed in all these series of practices was at the following rates in order: 60, 66, 72, 80, 88, 96 and 104 per minute, there being always six practices at the slower rates before the most rapid rate, 104 per second, was reached, thus gaining considerable adjustment at these rates before the higher rates of speed were practiced. But for matters of comparison the results are just as good as though we had the full practice curve at each rate, because our figures represent all the curves compared with the same amount of adjustment practice.

In this discussion we shall use only one rate, the 104 rate, for comparison of the interference which takes place when the order of stimuli to responses, or the serial order of stimuli or responses is changed. By referring to the tables of the results, it may be seen that any of the rates, if compared, will show about the same proportion of interference with number of prac-

tices and proportional number of practices required to eliminate the errors at that rate. Plate I. shows graphically the results of this experiment, and the relation between the 'interference' and the number of practices required to become readjusted.

The third experiment, the results of which are represented by Tables V. and VI., and by Plate II., shows, like the experiment just discussed, the number of errors at each rate per minute and the number of practices at that rate per minute required to eliminate the errors. It likewise shows the interference when the order practiced was changed and the number of practices required to gain readjustment. The advantage of this experiment over the previous is that it shows the complete practice curve at each rate and the real 'interference' at that rate when the order is changed, and in this way the 'interferences' at the different rates may be compared with each other. Instead of each subject practicing daily through the series of rates, as in the previous experiment, he practiced at one rate only (one subject for each rate). The results show, like the first, that the more rapid the rate the more errors, the more practices required to eliminate them, and the greater the 'interference' when the order is changed.

At the 104 rate, 46 errors were made in the first practice and it took 66 practices to overcome all the errors at this rate, and when the arrangement of keys was altered, after perfect adjustment was brought about through practice, at this 104 rate there were 34 errors and it took 37 practices to eliminate them. When now the series was changed 13 errors were made. At all the rates in this experiment the relations were somewhat similar, but not so much so as in the experiment immediately before this. Those practicing the higher rates became adjusted comparatively more rapidly than those practicing at the lower rates. This is due, probably, to the fact that the four subjects who practiced at the higher rates had acted as subjects in the previous experiment, and it is possible that this enabled them to get adjusted more rapidly than the naïve subjects. If this is true it shows that training in one function gives us at least power to learn in another similar function more rapidly than without that training. It shows that training in one situation creates capacity to receive

training in another similar to it; also (it might be argued) that understanding one situation better prepares one to grasp and comprehend other situations.

The results of these experiments show that every time the color series or the keys of an order practiced are changed there is 'interference,' and it requires a certain number of practices proportionate to the rate to make readjustment, and thus quantitative relations are determined. The number of errors at the same rate per minute and the time required to eliminate them are in no case as great as when at first practiced. The tables further show that neither the 'interference' nor the adjustment practices required are as great when the order of stimuli is changed as when there is an alteration between responses and stimuli.

Münsterberg[1] was not wrong when he concluded that it takes less time to relearn a habit each time we return to it, *e. g.*, if we had once learned to react to a stimulus A, or a series of stimuli A, A_1, A_2, . . ., A_n, respectively by act M, or a series of acts M, M_1, M_2, . . ., M_n; and in the meantime we reacted voluntarily to the same stimulus A or series of stimuli A, A_1, . . ., by act N, or series of acts N, N_1, N_2, . . ., N_n until these responses became automatic, each time we return to act M, or series of acts M, M_1, . . . it takes less time to relearn to respond by that act automatically. And if we keep on returning from one response, or series of responses, to another, for several times, both become automatic, and one can react equally well by either response. One needs but *start* the impulse in the direction of one of the responses M or N, and the act ensues as easily and automatically as though no other act had ever before been associated with the stimulus. When I had learned, *e. g.*, to respond automatically to series A on the typewriter by both the key arrangements A and B, I could, after a few alternating practices, run over either arrangement equally well at the 104 rate, the interference having become less and less with the alternating practices, following somewhat the practice curve, until no more interference was experienced.

In Plate I. the time curves T are plotted with the same coordinates as the error curves, except that because the physiological

[1] See review of his work on page 8.

limit for speed was found to be about 30 seconds to run through the series, and, in order to make the time and error curves comparable, 30 was regarded as the zero point for the time curve, and the number of seconds, less 30, it took in the successive time experiments was plotted in the same way as the errors. It can be seen empirically that the two are not strictly comparable. However, the error curves, as well as the time curves, when compared with each other for the different rates per minute, show that the slower the rate the more rapid is the decrease in the number of errors with the succeeding practices. In the slower rates the decrease in the number of errors is at first quite rapid and then more slow, while in the more rapid rates the decrease is more gradual throughout. The time curve also drops rather rapidly at first, and then more gradually. In the 129th practice when the average subject could run through the color series without an error at the 104 rate, the average time at which he could run over the series at his own rate was 37.5 seconds. This shows that at his own most rapid rate it took 5.5 seconds longer than when keeping time with the metronome. It is difficult to understand the reason for this, but an analogous case is that of an army on the march. Every one knows that it is easier to march to time. An almost exhausted army will start up with new vigor when the drummer begins. Another explanation might be that the beating of the metronome serves to keep one excited and thus helps to hold the attention to the experiment, whereas without this, when the attention wavers much time is lost. Table X. shows that the greater the number of different reactions in a number of series of the same length, the longer it will take to go over the series, the more rapid the adjustment and the greater the 'interference' when the order of reaction is interchanged. This is probably due to the impossibility of shifting the attention rapidly enough. Any motor operation which requires much shifting of the attention offers much resistance to speed both at first and when antagonistic reactions are to be learned. The other general experiments summed up in Tables VIII. to XV. will receive attention in our more general discussion.

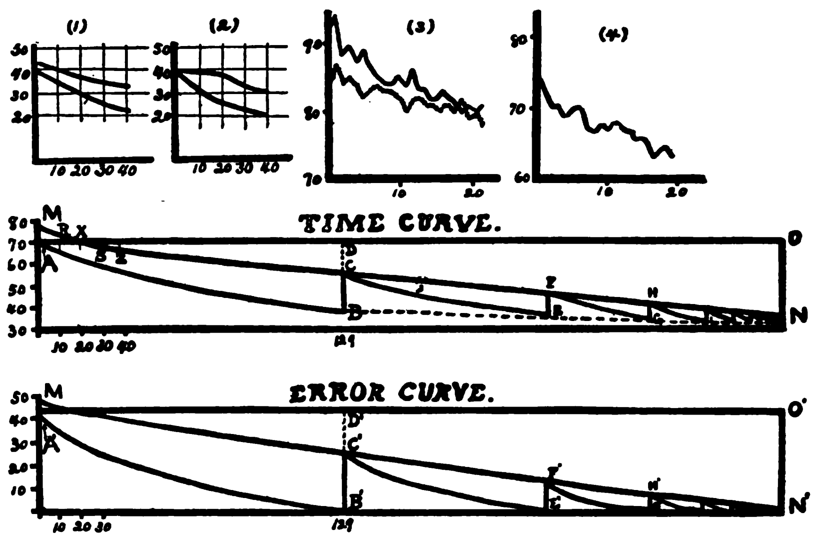
Coming now to the subject of *Interference*, it is difficult to decide; but if our interpretation is correct real interference

plays a very small part in our mental life. Of course, it depends largely on what we mean by interference. If (referring to our diagram 'Time Curve,' Plate III.) we call *BC*, the increased time required when the order of responses is interchanged, interference we shall not take issue with those who argue for it; but if we mean by interference such an increase in time upon a change of the order of responses that the point *C* of *BC* falls above the line *AO* representing the time of the first practice in the first order, then from our results it can be argued as doubtful whether there is any interference whatever. Our results show, however, that when an order of reactions is made once, or only a few times, there is actual interference when an antagonistic order is attempted; but that this interference decreases proportionally to the number of practices until at between twenty or thirty practices of this order the interference is all gone and a continued practice has an actual practice effect on an antagonistic order. How much practice effect can be procured by an indefinite number of practices in an antagonistic order our results do not show definitely, but one is justified in assuming that it is considerable. Our results show that the practice effect on arrangement B by practicing arrangement A 129 times is *CD*, which is considerable. Without any practice with arrangement A, it would have taken at first to run through the same series on key arrangement B, *BC* + *CD* seconds, which is the same time it took to complete the series in the first practice on arrangement A. If our results justify us in drawing any conclusions, we might say that special practice or training gives general ability, or that learning to do one thing gives us capacity for learning to do other things, and the same thing in different ways.

Bergström argues that interference is a fundamental fact of the nervous system, and that an old habit always resists displacement. "It is easier to act in the old way, but it is not evident that we cannot learn a new way, if we try, *as easily* as we learned the old one. * * * In the small field of the present experiments it will appear, however, that in spite of every effort a very decided interference takes place when we attempt to associate a new reaction with an old stimulus."[1]

[1]*Amer. Jour. of Psychology*, Vol. V., p. 356.

Plate III.



DESCRIPTION OF PLATE III.

Curves (1) and (2) on this plate show graphically the results tabulated in Table XVII., page 37. Curve (3) shows graphically the individual results of two subjects who dealt the cards twenty times in succession, with one-minute intervals between the sortings and a five-minutes' rest in the middle of the experiment. Each time the cards were arranged in different order and placed in different positions on the table.

Curve (4) shows graphically the results of a comparison experiment to (3) on the typewriter. See Table VIII. The cnrve represents the average, or mean curve.

The 'time curve' shows schematically the results of the time experiments. It is based on Table III. and Plate I., the *flattened* curves. The ordinates, ~~like~~ as in Plates I. and II., represent in the time curves the time it took to run through the series, and in the error curves the number of errors at a constant rate, and the abscissas represent the number of practices. In the time curve 30 is taken as the base line because 30 seconds is about the most rapid rate any subject acquired in the practices, and is therefore considered as the physiological limit. Curve *AB* represents the first practice curve, *CE* the second practice curve when the keys were interchanged, *FG* the practice curve when the keys were again changed back to the first order. And the succeeding curves, *HI*, etc., represent the curves changing back and forth alternately from one order to the other until either became automatic. *BC* and *EF*, etc., show the *interference* (?) which takes place when one order is substituted for another practiced. *CD* shows the amount of practice we get in arrangement of stops *B* by practicing arrangement *A* 129 times, etc. The curve *MN* represents the practice effect one order practiced has on the time required to do another order

as yet not practiced. The part of the curve *MS* of *MN* is determined by the experiments described on pages 34 to 38 and results shown in Tables XVII. to XIX., also (1) and (2), Plate III. Points *M*, *R*, *X*, *S* and *Z*, and their corresponding positions on *AB* are determined by the experiment summed up in Table XVIII., page 37. The corresponding points on *M'N'* and *A'B'* of the 'error curves' (which is a schematic representation of the error curve of Plate I., and Table II. at the 104-per-minute rate), are determined by Table XIX., page 38.

A great deal of what Bergström interprets as *interference* is not that at all. The increased time a new order requires over the old practiced order is due to learning the new order, and not to resistance from the old. If there is actual interference as defined above, it is due to indisposition rather than to inability. We become a slave to a habit because we will not make the effort to free ourselves from it by a better or more desirable one.

In my later, more general discussion, I shall go more into detail as to the reason for the phenomena of these experiments. I shall take into consideration the physiological mechanism and the processes involved in the forming of associations. I shall take into consideration also a great many facts and phenomena of association observed, but not yet mentioned, which will help us to understand the physiological processes involved, and to advance a theory consistent with all the facts at hand. I shall, therefore, now proceed to a discussion and coordination of these facts, and their bearing on my theory and the results of the experiments obtained by others.

Our experimental results show, as also do Münsterberg's, that a habit associated with a given sensory stimulus or series of stimuli can continue automatically while some effect of a previous and different habit associated with the same stimulus or series of stimuli remains. And by returning to the old habit each time one becomes automatic, it takes less and less time to relearn that habit, until finally either of the two habits becomes automatic, one needing but to start the impulse in one direction or the other, and the responses continue and the adjustment is maintained just as easily as though that were the only response or adjustment ever acquired to that situation.

These results corroborate the phenomena of everyday life—social phenomena, for example; people brought up in one dis-

trict become better and better adjusted to the conditions of that district and acquire the provincialisms and the conventionalities of that district. These provincialisms are the more marked in rural districts not subject to a wide communication and the influences of the world. The young folks of such a district are taught and coerced to respond in a way consistent with the social habits and customs of that community until their reactions have become automatic. If now a young person, thus adjusted to the moral, social, religious and economic traditions of a community, leaves that community and goes to another where these conditions are different, he gets homesick. Any one who has for several years attended a boarding or dormitory school has heard a great many epithets of description, such as, *e. g.*, bashful, fresh, young, green, new, slow, etc., applied to the students of the younger class, which characterize this resistance to the new responses which an adjustment to the present environment demands.

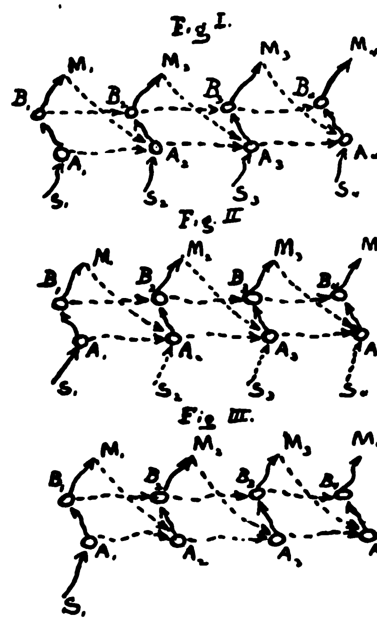
It has also often been noticed that young people who have been away from home for but a year or so (this applies especially to students) make themselves both uncomfortable and disagreeable when they come home for a vacation. They have become quite adjusted to the new situation, and when they come back they find the people uninteresting and 'slow,' and they are in turn considered as 'stuck-up,' affected, etc. One who has been away from home for a number of years and has occasionally come back to his old community for a vacation, finally does not any more attract attention, but usually enjoys his stay at home very much. These phenomena are universal and must have a physiological basis. The oftener one returns from one environment to another the less will grow the resistance. He will finally learn to conform quite easily and agreeably to either situation. The traveler who goes continually from one set of conditions to another eventually passes as easily in any one, and can make himself as agreeable to the people of that community as though he never lived in any other than their environment and knew no other than their customs, traditions and beliefs. He becomes an almost automatic conformer wherever he goes, however great the social diversities. He is at home with beg-

gars or kings, with business men or society ladies. He is a citizen of the world.

Foreigners coming to this country are easily pointed out, but after they have been here for some time they become adjusted, and pass as normal citizens. If afterward they return to the fatherland and remain there for a time and then come back, after doing this for a number of times they cannot be distinguished from ordinary citizens either here or abroad. Institutional children feel shy outside the doors of their institutional home, but after being sent out for a number of times on the streets, and to school, they become like other children. They will act like institutional children while inside their own yard, and like children of the streets while on the streets. Richard Mansfield can be Dr. Jekyl one moment and Mr. Hyde the next. With much practice it has become very easy to alternate from one to the other. It seems, therefore, that the social phenomena we see about us in ordinary everyday life are founded on the same physiological basis as those of the habits formed and broken in these experiments, and that a physiological explanation of these will also be adequate for all the social phenomena of life. The physiological explanation which I shall offer of the phenomena of our experiments can, I believe, be generalized so as to offer a solution for the phenomena of our mental life in general.

How can these phenomena be explained physiologically? Figures 1 to 3 show a graphic representation of the neural connections that are made in the forming of a habit. The formation of a habit involves two things, a connection between stimulus and response—*i. e.*, a sensori-motor connection and a sequential connection between the stimuli—or the responses, in serial order. In the case of our experiments a definite connection was gradually built up between each color and the definite response to it on the keys, and also between the colors in serial order as successive sensations, or as successive responses. The Figs. 1, 2 and 3 show schematically what physiological changes take place when a sensation, or series of sensations, is responded to voluntarily by a movement, or series of movements, and how through repetition these connections become *clinched* so that the movements follow automatically the stim-

uli. In Fig. 1, S_1, S_2, . . . represent certain sense impressions which are conveyed by the proper dendrites respectively to the



In Figs. 1 to 3, S_1, S_2, . . . represent the individual sense impressions coming in in serial order to the sense nuclei A_1, A_2, . . . and these are respectively discharged into motor cells B_1, B_2, . . . so as to bring about the voluntary movements M_1, M_2, . . . Besides these sensori-motor connections there are also connections made between the motor cells B_1, B_2, . . . , in the order discharged, and also between the sensory cells A_1, A_2, . . . , in the order stimulated. There is further a third connection made between the sensation of the movement M_1, . . . and the sensation from the stimulus S_2, . . . which discharge A_2, ... Finally, only sensation from the movement of the previous discharge of the M cells is required to set off a discharge in the A cells, and the act continues, Fig. 3, without the sense impressions S_2, . . .

sensory cells A_1, A_2, . . . in the brain. These cells discharge respectively into motor cells B_1, B_2, . . ., and these discharging, in order, send the motor impulses, by means of their dendrites, to the muscles which produce respectively movements M_1, M_2, ... Thus, with a number of repetitions a definite sensori-motor path S, A, B, M is established, so that when S_1 is presented M_1 follows automatically in consequence. Likewise, if S_2, S_3, . . . are presented, M_2, M_3, . . . follow also. The oftener a sensori-motor process is repeated the more definite and

unerring become the connections, until when a sufficient number of repetitions have been made the connection becomes permanent and a habit is formed, and we respond to a given *S*, nonvoluntarily, by a specific movement *M*. There is also a strong connection formed, as these experiments show, between cells that for a number of times have been stimulated or discharged together or in succession. Physiologically the law of contiguity of association might be stated as follows: Cells that have been stimulated or discharged together, when one is stimulated or discharged, the others tend to be stimulated or discharged also, and the oftener cells have thus been associated together when any one is stimulated or discharged, the greater the tendency of the simultaneous stimulation or discharge of the others.

But our experiment is concerned mainly with the law of succession, which might be stated as follows: Stimuli, or responses which have followed in serial order when one of these stimuli is presented, or one of these responses is made, the other stimuli or responses tend to be called up in their serial order. Our experiments show that the strongest connection is made between the individual stimuli and their responses. These are the sensori-motor connections. But there is also a strong connection formed between the cells that have been for a number of times in function in serial order. This connection is represented in Figs. 1, 2 and 3 by the dotted lines between the cells. The discharges of the sensory and motor cells A_1 and B_1 become connected respectively with the discharges of sensory and motor cells A_2 and B_2 which follow immediately in serial order. The oftener the process is repeated, as in the sensori-motor connections, the more permanent and definite the connections. And the persistency of this connection can only be realized when the serial order is changed. Our typewriter experiments definitely show that such sensori-sensory, or motor-motor connections are formed, and are more than half as strong as the sensori-motor connections.

There is also, apparently, a third way in which connections are formed in our mental and active life, *i. e.*, interconnections between the sensori-motor, the sensori-sensory, and the motor-motor processes. When for a number of times a series of sen-

sations, accompanied by their respective responses, follow each other in a definite serial order, the sensation of the movement of the response to each of the stimuli in the series gets associated with the sensation of the succeeding stimulus, and these two sensations together discharge the sensory cell of the second stimulus, and this discharge causes the discharge of the motor cell, habitually discharged with it, and causes the second movement. The sense impulse from this movement is again associated with the impulse of the succeeding sense impression, and so the process continues to the end of the series. To refer again to Fig. 1 as an illustration of the physiological process, when the motor cell B_1 discharges, as a result of the discharge of sensory cell A_1, and causes movement M_1, the sensation of that movement plus the sense impulse coming from the second sense impression S_2 discharges sensory cell A_2, which discharges into motor cell B_2 and causes movement M_2, the sensation of this movement again being associated with sense impulse S_3, and so the process continues to the end of the series. The discharge of sense cell A_1, which habitually precedes in the serial order the discharge of sense cell A_2, changes the *tonus* of cell A_2 and renders it more irritable and susceptible to discharge. Likewise motor cell B_1 precedes in its discharge motor cell B_2, renders it irritable, and makes it more easily discharged. The oftener a process is repeated the greater the permeability between the cells associated, and finally the usual paths become so well defined that the impulse when once started continues automatically until the act is completed, even if not reinforced by the serial sense impressions.

Learning by heart a passage of poetry illustrates the increasing permanency of connection between the cells involved in the process of learning with the successive repetitions. For some time while the learning is in progress it is necessary to have the passage before the eyes. When we have just learned to repeat by heart and for some time after, especially if we are of the visual type, we image the passage while we are repeating. We project it before our eyes and see it there. We see the position of each word on the page as we proceed. If we are of the auditory type we hear ourselves saying it as we represent it to our-

selves. The motor type has less tendency to represent it in this way than the visual and auditory.[1] Figs. 2 and 3 represent what happens physiologically. When we have just learned to repeat by heart we image the sense impressions as we respond. In Fig. 2, sensory cell A_2 is discharged in consequence of its heightened irritability, by the discharge of sense cell A_1, which habitually precedes it, and the sense impulse, coming from the movement M_1, resulting from the discharge of A_1. Now when A_2 is discharged it brings to mind the external stimulus which had previously and habitually caused its irritation while the learning was in process, hence the imaging of the stimulus. If the process is sufficiently often repeated the vividness of the image as projected wanes and is finally dropped out altogether (Fig. 3). Eventually we can repeat the stanza or passage without any reference to where we learned it and to its position on the page, etc. The process becomes mechanical and needs but be started voluntarily. When started, like walking, it will go on automatically while the mind may be occupied by something else. The only stimuli necessary to keep the process in operation are the sensations of the successive movements as they follow in serial order in the process. Repeating a passage becomes as much a habit as anything else. Exactly the same physiological process is involved.

As our experiments show, we can learn to do several things, mechanically, in response to the same stimulus. At first there is great interference, but this interference is gradually reduced as the various responses are practiced. The same thing is true when we wish to modify a response or series of responses, to a series of stimuli which have become associated by repetition. I taught a four-year-old boy a comical song, which I had him sing after me until he could chant it himself. I then tried having him recite the song. This he could not do. It took quite a bit of effort to get him to recite it. Even though he could sing it without a pause or error, when required to recite it there were continual pauses and song intonations. Finally he could repeat it with all kinds of modulation. I

[1] This is an inference based on the results obtained from a number of people whom I asked the type they belong to and the method they employ in learning.

remember a certain superintendent requiring all the children in the public schools in his care to be taught to recite the patriotic songs of this country. While these songs were daily sung in the schools, it required almost as much effort to teach them as new poems. The modification of responses to stimuli is not arbitrary, but is as much dependent on physiological laws as the original learning.

In learning to respond on the typewriter to a certain definite serial order of color stimuli, respectively, by a definite serial order of reactions on the colored keys, when these reactions became automatic the subject could not *name* over the series, but he could respond them in their order on the keys in the same way he had learned them. This shows how highly specialized a process is. The memory lies in the specific response. The series can be reproduced only in the way they have been habitually reacted. This reaction cannot be transferred to the lips. When one can reproduce them in the way in which one learned them it is no guarantee that he can name the series in their order. Having learned to respond the series, however, makes it more easy to learn to repeat verbally.

The learning to respond a series takes place in the following manner: Each time we repeat the series, the sensori-sensory and motor-motor, as well as the sensori-motor, cell connections become more permanent. With every repetition the *pushing power* of each stimulus becomes greater because the resistance to its impulse becomes continually less and less, and the path better defined. At first this impulse must be reinforced by impulses, from sense-impressions of the series, coming in at certain intervals, in order to keep up the series of responses. But these reinforcing impulses can be placed farther and farther apart with the successive repetitions, until the first impulse is sufficient to set off the whole series of responses without any reinforcing sense-impulses except those produced by the impulses themselves.

In our experiments the subjects were tested to see how far they could reproduce the series of responses without seeing the stimuli. At first they could respond but a few ahead of the stimuli given, but finally, two of the subjects could reproduce the whole series without reinforcing stimuli.

We made tests, other than the interference tests already described, to determine the strength of connections between the stimuli, or between the responses in serial order. Color series A and color series C, as described on page 15, were very nearly alike, series C having colors different at but two places from series A. When series A had been practiced until no more errors were made at the 104 rate, then during the practice series C was substituted for series A without the subject knowing it. The responses came as if no change had been made. The sensori-sensory and motor-motor connections were strong enough to cause the subject to overlook or actually to see the two colors wrong. This shows that many of our illusions are due to the fact that serial associations are ofttimes strong enough to overbalance sensori-motor associations. We see what we are accustomed to see in the same situation, position or serial order. Ofttimes we can only remember a thing when the situation which usually precedes the experiencing of that thing is presented. In reproducing the series from memory we could not call up a sense impression in a series until experiencing the kinæsthetic sensation of the response to the stimulus preceding in the series. When a child learns a verse of poetry or a multiplication table, he cannot begin anywhere arbitrarily, but must begin where he usually begins. He must, if he 'gets stuck,' begin again at the beginning. If one has traveled a certain road, the second time he may be able to find it himself, but if he were called upon to tell some one else the way, he could not do it. He knows only the direction to take at certain cross-roads when he gets there. The first stages of memory consist in recognition, *i. e.*, in knowing whether the responses are the same as in the previous experience.

Other illustrations showing that memory is not an absolute thing, but closely associated with certain responses, which responses were those involved in the memorizing acts, are the following: If one were to give a written examination in spelling, for example, to a class that habitually recites orally, one might expect a much lower per cent. of rightly spelled words than if the examination had been oral. Some men who are good writers are poor speakers, and *vice versa.* Being a good

speaker is no guarantee that a man is also a good writer. He becomes good only by practicing writing. Being a good speaker makes one more apt in learning to become a good writer. One being able to spell well orally can more readily learn to spell well writing than a medium speller who can do best writing. A person who is able to produce good compositions when writing may find difficulty in thinking when writing on a typewriter. A certain young lady who had for several years been a typewriter in her father's office and who did nearly all her writing on the typewriter, found it difficult to spell when writing with a pencil. When writing essays in the university she would often lay aside her pencil to make imitative movements as if on the type-writing machine to help her recall how a word is spelled. Cases of this sort are familiar to every one.

It is a commonly accepted opinion among psychologists that there can be no sensation without response or to quote Münsterberg,[1] 'We do not know of a centripetal stimulation which does not go over into centrifugal impulses.' All our thoughts are accompanied by movements and are in turn conditioned by movements. The memory of anything gets bound up with the response, as has been already emphasized, and to reproduce a memory we need but reproduce the motor adjustments accompanying our experience of the thing remembered. Thoughts come to us when we assume their wonted responses. "If we wish to inhibit a thought we must inhibit its bodily adjustment."[2] When we assume the bodily attitude which habitually accompanies a certain mental state, that mental state follows. If we make a reaction which has been the response to a certain situation, that situation or stimulus is brought up in our mind. "When we say the brain thinks, it is the whole body which enters into activity."[3]

Stricker says that he cannot imagine a movement without by that means calling into play the actual muscular feeling, through the centrifugal impulse.[4] The fact that the bodily adjustment,

[1] 'Psychology and Life,' p. 92.
[2] 'Inhibition,' Breese, p. 16.
[3] 'Sensation et Mouvement,' Féré, p. 25.
[4] 'Bewegungsvorstellungen,' p. 27 ff.

even though arbitrarily made, recalls to mind the feeling and experience usually connected with that adjustment is very prettily illustrated by a two-year-old child whose associations I have studied. Last summer her father took her with him fishing, and she was taught to show how big a 'fishy' papa caught by spreading her arms. One day six months later, when for a long time she had not shown any one how big the fish was, her father had her standing on his knee, when all of a sudden she lost her balance and threw out her arms to regain it. This adjustment called to her mind her former association and she exclaimed, 'O, papa, fishy, fishy!'

Certain bodily adjustments which are responses to certain stimuli or situations, when often repeated either voluntarily or as natural responses, become habitual, and the body tends to assume those adjustments or attitudes. In this way dispositions are built up. And we hear of melancholy and jovial dispositions, etc. These habitual bodily attitudes inhibit thoughts whose bodily responses are antagonistic to the habitual bodily attitude of the disposition, and in this way our mental life is conditioned by the habitual adjustment.[1] 'All mental states are followed by bodily activity of some sort,'[2] and according to our view are conditioned and in a large measure determined by this activity. If the habitual adjustment is stronger than the tendency to respond in a natural way to a particular situation, the conscious effect of that situation will be inhibited or at least modified and colored by the habitual adjustment.

We become optimists or pessimists, altruists or egotists, by a selective habit. Every time we make a certain response to a certain stimulus we take a step toward forming a definite habit which is an element in our disposition. We cannot help forming automatic habits and thus definite dispositions. The problems of education are what kinds of habits we should form, what kind of a disposition we should cultivate, and hence what type of mental life we should have. The direction which our mental development shall take is determined largely by what

[1] 'Ueber den Einfluss der Gefühle auf die Vorstellungsbewegung,' Robert Saxinger, *Zeitschr. f. Psych.*, Bd. 27, Heft 1 and 2, p. 18.

[2] 'Psychology,' Briefer Course, James, p. 5.

bodily attitude we shall take. How we shall respond to a given stimulus depends on how we have responded, what we shall think on what we have thought, and the attitude we shall take on the attitude we have taken. What our past life has been determines in large measure what our present life and future life shall be. We cannot divide our life. Every one is conscious of this fact. A man who has been honest in his past dealings is trusted because everybody knows from experience that men generally live consistently with their past life. We become morally automatic. If the question of free will and determinism should come up here we would say that a man is free to will but he cannot choose his desires. He can choose between desires, but his past life determines what these shall be. There is a selection of desires just as there is of our mental content and of responses. Indeed, one is but another aspect of the other.

We can overcome an undesirable disposition by voluntarily assuming and holding ourselves in the bodily attitude of the disposition we wish to cultivate. The method is exactly the same as breaking up a bad habit. We cannot inhibit an undesirable disposition or habit, but we can voluntarily substitute desirable responses for undesirable ones, and thus eventually the new disposition or habit becomes automatic after a sufficient number of repetitions. Thus one habit or disposition can gain ascendency over another only after long and patient practice of that habit or disposition voluntarily. But if the old disposition or habit is referred to several times one is very liable to lapse. There remains a residue in the old paths, and a very few impulses will make them as permeable as ever. A good illustration of this is the habitual drunkard who had voluntarily abstained until he had overcome his old drinking habit, and then by taking a few drinks was brought back again to his old disposition. Men who have not thoroughly overcome a bad habit, when they relax themselves will ofttimes fall back to the old adjustment. Conversion is not an instantaneous process, but requires a long voluntary substitution of desirable responses for those condemned. The great temptation of the devil which converts experience is the feeling of strain in holding them-

selves in adjustment antagonistic to the habitual adjustment. It is the consciousness of a tendency to relax, to let the body assume its habitual adjustment, and to let the impulses go in their usual courses, and a feeling of exertion in directing the impulses in right channels.

In the same manner attention can be explained. At first we attend voluntarily. Holding our attention to a thing is responding to that thing—adjusting ourselves to that thing. After a while that adjustment becomes habitual, and attention in that situation becomes involuntary and automatic. Our attention is where our bodily adjustment is. It is always a strain to any one to try to attend to anything adverse to the habitual bodily adjustment. And as soon as one relaxes his voluntary effort he tends to fall back into his habitual adjustment, and consequently also his thoughts and attention lapse back to the situation of that adjustment. When we listen to an interesting lecturer whom we try to follow, we find our efforts interspersed with relaxations and our body going into its habitual adjustment and our thoughts wandering.

The person of a sad disposition has certain habitual bodily adjustments, such as a drooping countenance, pouting lips, downcast eyes, drawn-in chest and a feeble gait. This disposition can be overcome by following the common-sense advice of 'bracing up.' We cannot inhibit a feeling of sadness by trying to suppress it. "If one attempts to thrust out of consciousness an idea, or an emotion, the attempt serves only to intensify it. * * * The will is successful in inhibiting mental states only when working through the motor adjustments of the body. * * * A change of bodily activity tends to bring about a change of mental states."[1] We can overcome a disposition of sadness by keeping on bracing up until that bodily adjustment becomes habitual.

Whenever we are awake we hold ourselves in a certain adjustment to our environment. That adjustment is partly determined by our habitual adjustment, *i. e.*, our disposition, and partly by the stimuli present. When one is soundly asleep he is unconscious, and to be soundly asleep or entirely uncon-

[1] *Loc. cit.*, pp. 56, 2.

scious one must be completely relaxed. Whenever we are awake we hold ourselves in a certain adjustment to our environment, and like a tightened string we respond to the changes in that environment. Holding up one's head is action, and when we are asleep we are like a broken string, we are relaxed and do not respond. One dreams only before he is thoroughly asleep, *i. e.*, before his body is completely relaxed. Dreams can easily be interpreted in terms of response. Soundly-sleeping persons cannot dream. If in our sleep we get into some bodily adjustment or make some response which is the adjustment or response to some situation or sense impression we have made in some waking state, the images or situations of the dream will be those which brought about the same adjustment in some waking state. The *cue* to past experiences seems to be in the responses. A memory of a past experience comes up, as already explained, when we get into the bodily attitude of that experience. When we get into a bodily adjustment which was the response to a stimulus in the past, that stimulus is called up in our minds and imaged.

To go back to the figures again, when M_1 is produced, the sensation of that movement irritates A_1 and A_2 and the sense-impressions which habitually stimulate these cells will be imagined. Likewise in dreams if the adjustment M_1 is produced, the sense cells A_1 and A_2 are stimulated by the sensation caused by the adjustment M_1. In the case of sadness, etc., if one puts himself into a sad attitude, a memory of some specific sorrow will come up in his mind, a sorrow which he has experienced and to which he has responded by a sorrowful attitude. When one gets into the attitude M_1 there will be produced some specific sorrowful sight S_2, which is due to the projection of the sense-impression which usually stimulates sense cell A_2 now irritated by the sensation coming from the movement M_1 or the attitude M_1.

If we make a movement either by chance or in response to a stimulus, and if that movement is an element or contains an element of a movement which was made in response to a different stimulus, that stimulus is brought up in the mind. This explains quasi-thinking and mind-wanderings. If two responses

have been made together, when one of these is afterward again produced as a result of its stimulus being present, the other tends to be made also, and thus things that we have experienced together before tend to be recalled together. If we make the movement, or put ourselves into the attitude M_1 which has been the response made or the attitude taken in some past experience to S_1, then that past experience is brought up in our minds.

On this basis a great many of the mental phenomena, usually puzzling to the psychologist, can be explained, as, *e. g.*, the communication between minds when a number of persons are trying to entertain one another by telling stories; the stories one tells suggest stories to others in the following way: We follow the speaker with a continual response. This is shown by the fact that we become hoarse by listening to an interesting lecturer.[1] We are made to laugh or cry, to feel sadness, sympathy, hatred, revenge, etc. These are responses. If some of the responses which we are caused to make by the story, that is being told, are responses we made on a previous occasion when a different story was being told, that story is called up in our mind. A second story-teller ofttimes begins by 'That reminds me,' etc., and his story in a similar manner suggests stories to other members of the company. The cue to our past experiences lies largely in our responses. Memories of past experiences are brought up by our reactions. Our mental life is just as varied as our responses. We make infinitely more, and more varied, responses than the lower animals by means of gesture and our vocal organs, and this accounts for the difference in our mental life. Merely seeing a thing does not give us a knowledge or memory of it; we learn to discriminate only what we are called upon to react. Differences are forced upon us through differences of reaction we make. By means of language and gesture we are enabled to make more delicate discriminations than the lower animals. The animal's responses are confined to narrow limits. We are taught to make delicate responses. We are taught to *describe* a thing. We are taught to read and write and in this way we are obliged to make fine discriminations. We are taught arbitrary responses to sense

[1] 'Inhibition,' Breese, p. 16.

impressions, and these responses afterward become the cue to the object for which they are the reactions.

The child is taught to make certain conventional responses to the things he comes in contact with. For example, he sees a certain animal; he is taught to respond to it in a definite way, *i. e.*, by the vocal response *cat*. Likewise he is taught similar responses to all other animals and things. These responses become definitely associated by repetition, respectively, with these things. Through education, through the bringing together of experience by means of language, things become associated which without language could never be experienced together or be associated. Language makes a community of responses possible. All have been taught to make the same responses to the same sense impressions. Language is the most conventional thing the human race is in possession of. It is the means by which we can reexperience the experiences of the past. By reading a book—a history or drama—we can experience the experiences of that drama. As we pronounce the words, which words are respectively the responses to certain sense-impressions we have already made, that pronunciation calls up images of the objects of which these are the names. And in this way one makes an indefinite number of associations otherwise impossible. We discern things only in so far as we respond to them. The animal makes a gross response to a general situation, whereas we learn to discriminate very sharply. We learn to describe, to notice details, but without language and gesture we could not do this.

Now if it were not for language, this artificial way of responding to our world of things by giving them names, our mental content, and our associations would be comparatively meager. By means of language we are enabled to associate experiences which are far apart in time and space by responding them together or in succession. If we make any response, either to a stimulus present or as a result of a response to some stimulus in the previous moment, there is a tendency for that response to be accompanied by other responses which accompanied it before, and to be succeeded by responses which followed it at some former time, the physiological process involved

being precisely the same as that already explained, page 49, in case of our experiment. In this way the mental content at any one moment and the trend of thought can be accounted for and explained.

A great deal of our past experience is bound up with our speech organs. When we think, our vocal organs are slightly innervated. Children cannot think without innervating their vocal organs considerably. This vocal innervation is greatly reduced in the adult when he studies, but that it is not entirely absent is shown by introspection. We cannot think except in terms of responses, *i. e.*, the words by which we represent to ourselves the things to be thought about. Our thought is inhibited when we suppress the motor responses of the speech organs. Smith[1] found that counting had no effect on the memory for series whose motor adjustments were made by parts of the body not involved in the counting process, whereas it distracted the memory greatly for nonsense syllables whose motor adjustments involved the speech organs. The results of W. G. Smith and Cohn, also reviewed at the beginning of this article, likewise corroborate the theory herein advanced.

We have made experiments showing that very little can be remembered of what transpired in our presence when the body was completely relaxed. The experiment consisted in reading a passage to the subject while lying on a couch thoroughly relaxed, and then seeing how much of the passage he could reproduce. Sometimes not a thought in the passage could be remembered. Introspections received from a score of professors and students of psychology show that one cannot think *a*, *b*, *c* · · · rapidly and at the same time repeat *1*, *1*, *1*, · · ·, nor can one think alternately lower and upper *do* without innervating, or a tendency to innervate the speech organs.

An experiment which I made last year,[2] in which I learned to move my ears, shows a striking illustration of how a response becomes the symbol of a sense impression or a situation. I learned to move my ears in the psychological laboratory of Michi-

[1] See my review of his work, page 11.

[2] 'Development of Voluntary Control,' PSYCHOL. REV., Vol. VIII., No. 5, Sept., 1901.

gan University, and now whenever I move them a picture of the laboratory is brought up in my mind such as I saw when I learned to make the movements. This again shows that if we put ourselves into a bodily adjustment which was a previous response to some particular situation, that situation tends to be called up and imaged. Any response, whether of the vocal organs, of gesture or of the viscera, which has been a reaction to some stimulus, when now made either arbitrarily or by chance is likely to bring up that stimulus in the mind. If we affect a bodily attitude which usually accompanies sorrowful events we can bring about a sorrowful feeling, and some specific sorrowful event in one's past life is usually called up. Specific reactions tend to be accompanied by specific memories; this is true, at least of the vocal reactions. The body seems to be a machine for making specific reactions to specific stimuli, and when a specific reaction is arbitrarily made it calls up the stimulus with which it was formerly associated. When a reaction to a stimulus present has an element in common with a reaction formerly made to a different stimulus, that reaction tends to call up the former stimulus.

We are becoming more and more convinced of the importance of the motor element as a factor in our mental life. From the standpoint of the function of this element we have already discussed association, discrimination, memory, sleep and dreams, habit, disposition, interest and attention, mental content and the trend of thought. On the same basis reasoning, imagination and the other mental processes could be accounted for.

The question now comes up whether special training gives general ability, and if so what is the physiological explanation for the same? One holding that the body is a machine for making specific reactions to specific sense impressions or situations would at first thought probably say that training or education consists in a number of specific abilities and that there is no such a thing as general training, and if he held such a theory would doubtless be accused of inconsistency. But if he considers the physiological processes involved he is more ready to modify his views. Admitting that education consists largely in learning to make certain responses to certain stimuli and inhibit-

ing others, thus forming desirable habits, we must also admit that learning to make these specific reactions also helps us to locate ourselves in our physical world. As soon as we grasp the significance of the motor element we see that any bit of special training also helps us to receive training in general. Any training helps us to find ourselves. It gives us a method of orientation which leaves us in our reactions not entirely to the mercy of chance even in unfamiliar situations. The experience which we get from special training gives us a general power to meet an entirely new situation with a more favorable response than had we not had this special training. We learn to react to a certain sense impression in a way that brings about the desired end through trial and error. We have learned in a similar manner to respond to a great many sense impressions or situations in such a way as to bring about pleasure or avoid pain. To a new situation, therefore, we react by a discriminative reaction and are more likely to hit upon a favorable response than without this special training.

To be more concrete, suppose one is called upon to imitate a sound the like of which he never heard before. He will be aided by his general experience in imitating other sounds, and that general experience helps him to direct the imitative impulse. It helps him, *e. g.*, to send the impulse to the vocal organs, if nothing more, instead of to the hand or foot, which would be imaginable if he had never had experience either in imitating sounds or moving his hand or foot.

Let Fig. 4 represent the brain and its motor connections, *N* representing the center of coordinations, and *A*, *B*, *C*, . . . the general motor tracts. *A* represents the motor tracts to the lower limbs, *B* to the arms, and *C* to the speech organs, etc. Now, as in the case supposed above, in which special training gives us a method of orientation, it helps us to express ourselves in the gratifying direction, *i. e.*, helps us to send the impulse into the channel *C*, that innervating the vocal organs, instead of channels *A* or *B*, which would result, respectively, in a movement of the leg or a flirt of the hand. Our general experience, the experience resulting from special reactions, helps us, in our attempt to imitate the sound stimulus, to react in the direction of

C rather than in that of *A* or *B*. If we could imagine a being with imitative impulses, but with no experience of the results of definite responses to definite stimuli, and with no sensori-motor associations, then the chances of the imitative impulses going in the direction of *A*, *B*, etc., would be evenly distributed. Special training, therefore, gives us general ability in that it

Fig. IV.

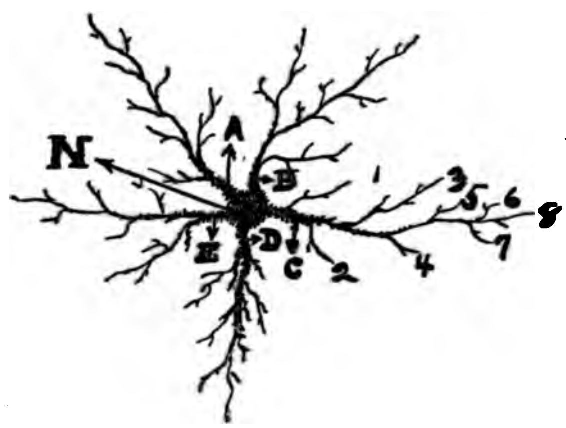


Fig. 4 is a schematic representation of the brain and efferent nerves. Branches *A*, *B*, *C*, . . . are the motor nerves supplying the different parts of the body. *C* supplies the vocal organs and 1, 2, 3, . . . represent branches of *C*, which, when innervated, produce respectively different sounds. The figure will be discussed in the text.

gives us a method of orientation, and thus we are benefited in a general way by our past experience.

Our sixth experiment, described on page 24, the results of which are summed up in Table VIII., page 25, seems to show that special practice gives general ability, as well as special. The first three subjects were new, and served only in this particular experiment, while the fourth subject, Sm., served in all the experiments. It might be argued that the practice effect here is due to getting adjusted to the typewriter in general, as, *e. g.*, getting accustomed to the stroke of the keys, learning to expend just about the right amount of energy, learning or getting accustomed to seeing the stimuli. We are willing to admit

that some of this practice effect is due to these factors, but why should Sm., who had long since gotten adjusted to all those conditions by many previous practices, also show almost as much practice as the others? This is difficult to explain unless we admit the point at issue. Others of our experiments lead to the same conclusion. The results of these will be discussed later.

The *a*, *b*, *c* tests described on pages 27–28, Table XI., p. 28, might throw some further light on the theories already advanced, concerning the physiological process of association. We see by the table that in the *a b c* series, *i. e.*, repeating alphabet forward, there was very little time gained by practice. This is due to the fact of former practice, whereby the sensori-motor and serial connections were definitely established. When this serial association was interrupted by placing a letter between each of the letters in the series (*an*, *bn*, *cn*, etc.) there was much interference at first, but adjustment was very rapid. This is shown by the curve, Plate II. When the series was repeated backward (*z*, *y*, *x*, . . .) the curve shows the same rate of rapid adjustment, as also does the curve when the backward series is intercepted by a letter (*zn*, *yn*, *xn*, . . .). When the forward practice was begun the subjects had already had considerable practice in repeating the alphabet, hence the serial coordinations were pretty well made. In all the alphabet experiments the sensori-motor coordinations were thoroughly made by previous training; the practice consisted in establishing the different serial orders. When the letters were intercepted by *n* there was great interference, the reason for which can be understood when the physiological processes involved are considered. Using once again Fig. 1, if cell A_2 is discharged either by a sense impression S_2 (the picture of a letter), or by a sense impulse coming from the movement M_1 (feeling oneself saying the letter preceding), or by both, in our case by the latter, *i. e.*, the kinæsthetic sensation only, this discharge of A_2 affects the tonus of A_3, and the discharge of B_2 which results from A_2 affects the tonus of B_3 which usually follow in their discharges in serial order the discharges of A_2 and B_2 respectively. The kinæsthetic sense impulse from the movement M_2

coming back to A_3, if not inhibited, is sufficient to discharge A_3, which would again render A_4 irritable, discharge B_3, irritate B_4, produce movement M_3, and impulse from M_3, discharge A_4, and thus keep the process going automatically to the end of the series, as they are habitually responded. But where a letter is to be intercepted, when A_2 is discharged into B_2, the processes as associated would now discharge A_3 and B_3, but this discharge must be inhibited by voluntarily discharging A_n and B_n, then A_3 and B_3, A_n, B_n and A_4, B_4, etc. Every time this new serial process is repeated, when A_2 and B_2 are discharged, the irritability of A_n and B_n becomes progressively greater, while that of A_3 and B_3 less, until finally the new serial progress becomes automatic.

Now, as I have already shown, there is probably not such a thing as *interference*. When we practice the *sn*, *bn*, *cn*, . . . series until we have acquired great speed, and then refer again to the *a*, *b*, *c*, . . . series, we find that we can repeat as rapidly as ever. It is also shown that we can learn the *an*, *bn*, . . . series more rapidly after having learned the *a*, *b*, *c* order than otherwise. Learning the alphabet in any order helps to learn it in any other order.

The child in imitating anything, *e. g.*, a sound, has in a general way connected sounds with their reproduction by himself, and he has learned in what direction to send the impulse in order that he may reproduce a sound. Referring for a final time to Fig. 4, suppose the sound to be represented is produced by sending the impulse to *8*, but he sends the impulse to *3*, and is dissatisfied with it, tries again, and now produces *1*, still farther away, which he will recognize. He tries again and may continue until he gets a gratifying response. In this way he learns that certain vocal innervations produce certain sounds. He learns to find himself as much by his unsuccessful reactions as by his successful ones. He learns the conditions under which certain responses are produced and he can arbitrarily make any response he has ever made, and these past reactions have given him a method of orientation. For example, if a person has learned to sing over the scale of notes up to *Si* and has never produced that note, he is more likely to hit upon it in an attempt

to imitate it than if he had never produced the series. He gets control of his vocal apparatus, and is able to produce sounds he has never before produced by the method of experience. Having once made a certain response is no absolute guarantee that one can reproduce it voluntarily; the oftener he repeats, however, the more command he will have of that response.

This is shown by the experiment of throwing shot into a cup, Table XIV., p. 30. We make certain movements, attempts to accomplish some end; in this case to put the shot in the cup. Our first attempt may be far of the mark, or it may be successful. In repeated attempts we are sometimes successful and sometimes not. But we gradually eliminate the unsuccessful responses, and if we practice long enough our results will be unerring, and there will be no more wrong responses. In learning to do things we ordinarily learn to do them only so well that we can get along. Bryan and Harter have found this to be the case with telegraphy. This they called the first plateau of proficiency, but an expert must go beyond this and by extra effort ascend to a higher plateau of proficiency. This is what distinguishes a Cinquevalli from an ordinary juggler. He makes no more wrong reactions, but hits his mark every time. A practice curve represents in a certain number of trials a certain distribution around the mark aimed at. This distribution is more or less scattered. With increased practice the distribution of hits becomes more and more concentrated about the mark until finally, if the practice is long enough continued, only comparatively few efforts will fail of their intended goal.

The way, therefore, that all these phenomena of practice must be interpreted from a physiological standpoint is in terms of selection. The outgoing impulse is arbitrary just in so far as it is not determined by experience. The coordination of the results of our effort and the end sought to be attained by that effort give us a working basis toward adjustment by means of selection. Better adjustment is due to the elimination of unsuccessful reactions which were made in pursuit of some end. I believe that a right interpretation of our facts as schematized

in the last two figures, Plate III., would be to say that there are two factors involved in practice, first, as just stated, a better adjustment through a selection from all the reactions of the most gratifying, the rapidity of this selection, in one case, being represented by the curve A', B' of the last figure, Plate III.; secondly, the more general factor, that of experience. Everything in the world of experiences is related because all is bound up with the reactions of one experiencing subject. We are put into our world ignorant of its laws. We find ourselves through trial and error. The wrong reactions of one situation ofttimes afford us a means of adjustment to another situation. We *find* ourselves in our world just as much through error as through gratifying reactions. We are rationally adjusted to our environment just because a whole past has made wrong reactions. We find the law by means of transgression. The past has therefore paid the price for our freedom. Experience rationalized, experience largely made up of errors, gives us a method of orientation. This method gives us insight, power to grasp the situation to which we are called upon to respond; our reactions are at once discriminative. The animal, just because it is reflexly adjusted to its environment, does not have this discriminative reaction, and hence cannot have reflective experience. It cannot survive a change of conditions. The quantity of insight we get to grasp the situation is represented in our diagram by curve M', C'. The more bearing one thing, that we have practiced, has on another, which we are called upon to react, the better we are prepared to make a favorable response, and if the two situations were exactly alike M', C' and A, B would coincide, *i. e.*, any amount of adjustment in one would give a similar amount in the other. We reason in a situation. We compare this situation with a situation we have experienced. We note the likes and differences and draw inferences. And in this way special training, learning to do particular things, gives us general ability and a method of deportment. Training implies not only the sum total of special abilities practiced, but it also implies a working method whereby we meet the conditions of our environment rationally and in such a way as to bring about the end sought.

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The Psychology of Expectation.

BY

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THE PSYCHOLOGY OF EXPECTATION.

I.

Introduction.

The popular use of a term often has a different meaning from that given it in scientific writings. Even when the general significance is the same, there are implications and points of detail essential to a technical or scientific understanding of the expression which are unthought of in common usage.

All this is true of the term expectation. To the popular mind it means looking forward to an event which is to take place in the future; it refers to a very simple mental process which has the same relation to the future that memory has to the past; it is not of such practical importance as memory, and is dependent upon that faculty and developed from it.

Such is about the idea which the unreflecting mind has of expectation; but the simplest questions that can be suggested show its inadequacy for psychological purposes. What, it may be asked, is meant by 'looking forward'? What, by 'past' and 'future'? On what ground is it affirmed that the relation of expectation to memory is one of dependence and derivation? Is there not an incongruity in speaking of memory as coming before expectation? Does analogy fail here? Is the natural order reversed so that mentally one first looks backward and then later learns to look forward? In further criticism of such a view the suggestion may be ventured that expectation is, on the whole, a more practical power than memory. Suppose man could not look forward, and was obliged to walk into the future backward, as it were. What would be the meaning of his past to him under such circumstances? Could it have any other than an æsthetic significance, affording him pleasure and pain, without any possible purposive application? It is absolutely

essential to assume at least a contemporaneous reference to the future in order that memory and the higher thought activities may serve any practical purpose in conscious life.

Consideration must also be given to the deep significance which expectation has for self-consciousness. It is the assurance to each soul that its life is continuous, that its existence will not end with the present moment, thus furnishing at least half the basis for personal indentity. It is our sole immediate guarantee for the future. Without it the hereafter, to-morrow, even the succeeding moment would be a blank to us. All possibility of progress, physical, moral and scientific, depends on the power to anticipate.

Nor is expectation less important to the objective side of mental life. To know an object it is necessary not merely to understand its genesis, but to foresee its results. Its past history may explain its origin and method of development; but to take account of these items only, is to stop short of knowledge. There must enter in some assurance of future being and conditions, some prevision of future modes of activity. A pebble and a tadpole side by side in a pool of water, utterly different in constitution, are not what they are to us merely because of what they have been, but also because of what they may become. We are fully persuaded that everything which now exists has a future. This is as true of the inorganic pebble as of the living organism. An understanding of the potentiality of the object is just as much a part of our knowledge of it as is belief in its present existence and acquaintance with its previous history. In short, we do not understand the nature of anything unless we know what may be expected of it in the future.

It is clear from what has been said that expectation is no secondary nor insignificant phase of consciousness, but a fundamental and important process. It furnishes a large factor in both knowledge of the self and of the external world and is an important element in moral conduct. The expectation-image is never looked upon as final, as an end in itself, but as the forerunner of a larger experience. It is a part of the teleological outfit of the mind making possible the construction of ideals and the pursuit of ends.

It is the purpose of these pages to investigate the nature of the process, the part it takes in the development of conscious life, its true relation to other mental activities and its consequent value in helping to determine our knowledge of the world and of ourselves.

Before entering upon this investigation, let us note what treatment the subject has received from other writers.

Historical Sketch.—There is not much material for a strictly historical sketch of the concept of expectation. Most modern psychologists give it a place among the constituents of mental life, and we shall in a moment consider the trend of their views. Earlier writers, taking a more rationalistic view of mental subjects, overlooked the importance of expectation as a psychological process. Time, space and cause were interesting to them as eternal verities and not as mental constructions more or less dependent on concrete experience. It must be remembered also that, in general, the future was regarded as a sealed book, open only to the eye of divinity and revealed by miraculous power to the favored class of prophets and seers. To identify such knowledge as theirs with commonplace anticipations would have been considered presumptuous. This, indeed, was the feeling in the seventeenth century, when Hobbes, with all his empirical predilections, wrote: "The foresight of things to come, which is providence, belongs only to him by whose will they come."[1] But the psychological instinct was strong in Hobbes and he goes on to say that foresight and providence are the application of past results to future acts. "By how much one man has more experience than another by so much is he more prudent and his expectations seldomer fail him." Again he refers to this foresight as mere guessing. "Therefore he that hath most experience in any kind of business has most signs whereby to guess at future time." Here we have a definite reference to the process of expectation; but its fundamental character is not realized and so it is not given a place beside memory as a necessary and distinct factor of psychical life.

Locke has nothing explicit to say of expectation, but he is

[1] 'Leviathan,' Edition of 1651, p. 10.

evidently reaching toward the idea in his analysis of probability, since he states the ground of this to be "that which makes us presume Things to be true *before* we know them to be so."[1] The relation of expectation to probability forms an interesting point for our later consideration.

In the writings of Hume we find expectation suddenly raised to a high office. Being a prominent feature of the universal law of habit, it is made the main factor in the concept of causality. No doubt Hume exaggerated the part which expectation plays in the formation of this concept. Mere repetition of events issuing in mechanical expectation could never give rise to the causal idea. Nevertheless, psychology owes a great debt to Hume for showing that anticipation of the future is a legitimate psychological process taking an important part in our knowledge of the world. Take the following passage as an illustration of what we may rightly call his discovery of the worth of expectation as expressed in custom: "It is this principle which renders our experience useful to us, and makes us expect for the future a similar train of events with those which have appeared in the past. Without the influence of custom we should be ignorant of every matter of fact beyond what is immediately present to the memory and the senses. We should never know how to adjust means to ends or to employ our natural powers in the production of any effect. There would be at once an end of all action, as well as of the chief part of speculation."[2]

All rationalistic writers considered time, space and cause as innate or *a priori* ideas, and from such thinkers no psychological analysis could be expected.

Kant contributes nothing to our subject; his interest was too deeply buried in the function of the categories to dwell upon underlying psychological processes. However, expectation is undoubtedly involved in his productive imagination, whereby the sensuous intuitions were connected in time by the forms of the understanding.

[1] 'Essay Concerning Human Understanding,' Book IV.: 15, 3.

[2] 'An Enquiry Concerning Human Understanding,' Selby-Bigges Edition, pp. 44, 45.

Dr. Thomas Brown, who classifies the mental activities in a clear and orderly manner, calls expectation a form of desire, making this term include all prospective feelings which "arise equally from the prospect of what is agreeable in itself, or from a prospect of relief from what is disagreeable in itself."[1] Expectation is that form of desire which has a strong degree of probability.

James Mill is the first writer who coördinates expectation with memory in the development of our concepts of time and of reality. Our belief in external objects, he says, depends on our belief in that which is not immediately present to the senses. To believe in the existence of an object which we see before us, is "to have other ideas of a certain order of sensations aroused by the sight sensations. It is to believe that in such and such circumstances we should have such and such sensations."[2] So much for Mill's implication of expectation in immediate knowledge of the external world. Knowledge of objects wholly removed from sense perception must also be dependent on both memory and anticipation. Further than this he states that "belief in past existence, not memory, is belief in testimony and the uniformity of the laws of nature. But belief in testimony is an instance of anticipation of the future from the past, and belief in the uniformity of nature only another name for the same thing."[3]

Coming down to strictly contemporaneous writers, we find one notable contribution to the study of expectation; Dr. Hans Cornelius in his book "Psychologie als Erfahrungswissenschaft," has given more attention to expectation as a factor of 'experience' than any other writer. The principles of expectation and unity together form the basis of the continuity of experience. "Our recollections," he writes, "show us no experiences which are not followed by others; so that the concept of experience can no more be constituted without the thoughts of a following experience than without those of a past experience."[4] Some of his statements sound much like those of

[1] 'The Philosophy of the Human Mind,' Vol. II., p. 148.

[2] 'Analysis of the Phenomena of the Human Mind,' Vol. I., p. 255.

[3] *Ibid.*, p. 299.

[4] See p. 87.

James Mill, for instance: "The affirmation of the existence of a content not at present perceived, means that we expect to perceive it on the fulfillment of certain conditions."[1] Cornelius also brings out the function of expectation. All the ideational contents of consciousness are the effects of past experience. They are grouped together and termed the 'Vorbereitung'; and as a factor in this preparation expectation helps to put the mind in readiness, either consciously or unconsciously, for each new impression.

Further reference to this book will be made as the progressive treatment of the subject may suggest.

As has been said, most psychologists of to-day give some place to expectation among the phenomena of the mind, though many of them, it is true, do little more than mention it; nor are they wholly at one in their ultimate classification of the process. It is regarded variously as a feeling, an intellective element and as a form of attention or conation. With the exception of Dr. Brown, the writers so far mentioned have treated it as a cognitive factor.

Professor Ladd regards it as a relational feeling. This class of feelings is contrasted with those of a statical order. While the latter attach themselves to the content of sensations and ideas, the former pertain to the relations which hold between successive sensations and ideas.[2] No one points out more clearly than Professor Ladd in his philosophical writings the epistemological value of expectation. In "The Philosophy of Knowledge" he affirms that "all practical cognition implies the right and power to predict."[3] There is a "timeless cognition resting on grounds which cannot change and implying knowledge of the future as well as of the present and of the past." In "A Theory of Reality" occurs the following passage: 'Without development of time-consciousness in all its three forms, as consciousness of the present, consciousness of the past and consciousness of the future, no *knowledge* can take place."[4] Not very different from Professor Ladd's psycho-

[1] *Ibid.*, p. 110.
[2] 'Psychology, Descriptive and Explanatory,' pp. 182, 186.
[3] 'The Philosophy of Knowledge,' pp. 263, 265.
[4] 'A Theory of Reality,' p. 187.

logical classification of expectation is that of Professor Dewey, who places it under formal feelings which express a 'relation between an end arrived at and the activities put forth.'[1]

Among German psychologists, Jodl[2] makes a similar classification. He considers expectation as one of the feelings of tension or strain (Spannungsgefühle), and these form a subdivision of formal feelings. Volkmann[3] too, classes expectation under 'Spannungsgefühle.' But his real analysis of the process is given at some length in his account of the development of our time ideas. Practically he treats it as an intellective factor upon the same basis as memory.

Wundt speaks of it in one place as an emotion; but he too seems to find it most natural to discuss it in his account of the intellective factors. It is the simplest of the apperceptive processes, a passive form of the imagination and essential as an antecedent of volition. He suggests a distinction which I do not think is made elsewhere, between the images of memory and those of imagination, under which he includes expectation.[4]

Külpe, considering the chief characteristic of emotion to be the presence of organic sensations, places expectation among the emotions; but mindful of the absence of a constant affective tone, he calls it 'an objective emotion.'[5] Lehmann, who differs from Külpe in giving the process a distinct affective quality, that of unpleasantness, gives it a place in the general class of emotions.[6]

Professor James nowhere mentions expectation as a distinct psychical process. But he makes free use of the principle in his account of the 'Stream of Thought.' Recall the phrases 'feelings of tendency,' 'anticipatory intention,' 'foreboding of coming words,' 'the dawning sense of the whither.' Such expressions also warrant a presumption that he would class expectation as a feeling. Of its constant influence on mental life he says explicitly in the essay on 'The Sentiment of

[1] 'Psychology,' p. 273.
[2] 'Lehrbuch der Psychologie,' p. 644.
[3] 'Lehrbuch der Psychologie,' p. 336.
[4] 'Outlines of Psychology,' Eng. trans., pp. 179, 262.
[5] 'Outlines of Psychology,' Eng. trans., p. 321.
[6] 'Die Hauptgesetze des menschlichen Gefühlslebens,' p. 291.

Rationality,' "The fact is that our consciousness at a given moment is never free from the ingredient of expectation."[1]

A number of psychologists have treated of expectation in terms of belief. Reference has already been made to James Mill's account. The same view was adopted by John Stuart Mill, who made expectation correlative with memory in developing our ideas of the world and the self.[2] James Sully also speaks of expectation as belief in the future; and as he is considering belief on its intellectual side, and has previously discussed expectation in connection with memory, we may assume that he regards it as an intellective form of mental life.

The very satisfactory exposition of Ward[3] classes expectation with memory under the general head of ideational processes. He shows the bearing of expectation upon the development of the idea of future time.

Höffding[4] discusses the subject, both under the psychology of cognition and that of feeling.

Lipps characterizes the process as a representative activity, a striving of sensation, and in another place as the desire or longing of the idea to become sensation.[5]

Professor Titchener, although placing expectation at the head of a list of temporal emotions, says it is not emotion, but a state of consciousness like attention, that 'it is attention to something which is to happen in the future.'[6]

[1] 'The Will to Believe and Other Essays,' p. 77.
[2] 'Examination of Sir William Hamilton's Philosophy,' Vol. I., pp. 261, 263.
[3] 'Encyc. Brit.,' 9th ed., Vol. XX., p. 63.
[4] 'Outlines of Psychology,' pp. 133, 236.
[5] 'Grundthatsachen des Seelenlebens,' pp. 592, 667.
[6] 'Primer of Psychology,' p. 153.

II.

The General Character of Expectation.

Provisionally, expectation may be spoken of as a mental process or attitude in which certain ideas or images are regarded as substitutes for definite sensational contents which are to be experienced later.

There are certain general characteristics and differences which mark the process. It may be intense and vivid, accompanied by strong emotion making the whole organism tense and alive with nervous activity; or it may arouse no feeling, remaining in consciousness only as a passive and almost ignored factor. Again, expectations may vary in definiteness from the clearest, most distinct ideas to vague, formless premonitions of something other than the present experience, a bare consciousness that there is a beyond. We also speak of expectations as immediate and direct on the one hand, and as mediate and inferred on the other. They are immediate when the ideas at once introduce the sensations whose substitutes they are; mediate when the realization of the ideas stands at the end of a series of images. In the former case, the time and place concomitants are furnished by the present situation; in the latter, they are more or less distinctly suggested by the end image of the series.

A general notion of anticipation is gained by contrasting it with memory. This process is usually defined as the reference of present ideas or images to past presentations within one's individual experience; so expectation may be defined as the reference of present ideas or images to future presentations within one's individual experience. We see that both alike deal with ideas or images. In the case of memory these ideas represent the sensations which, with their escort of images, at one time made up the significance of some immediate presentation

or passing event. In the case of expectation the ideas present some sensational effect which shall at a later period become a present experience. We are awaiting, looking forward to a juxtaposition of circumstances that shall afford the stimulus for arousing the sensation in place of which we at present substitute the image. The same image may then serve in the case of memory to recall an experience, and in the case of expectation to foreshadow it. If this be true, how is it that we do not confuse the two states? Whether we are to refer the image to the past or the future is largely determined in each case by the supplementary contents of the total psychosis, and these it will be our task to consider in the analysis.

Another difference impresses us. The images in the two cases have different results in consciousness. They lead to different forms of feeling, different modes of motor expression. Memory is comparatively passive, while expectation is decidedly an active state of consciousness. Suppose a certain book, lying on my table, attracts my attention and suggests the friend who gave it to me. Now if this image has the memory characteristics, I mentally settle myself in my chair and dwell for a moment, with a mild glow of pleasure, upon the mental picture of my friend. This is what I have called the æsthetic aspect of memory. But if the image aroused by the book bears the expectation marks, say it suggests that I am to meet the friend to-morrow, I am mentally on my feet with head bent forward, eyes wide open and ears attent, ready for the meeting. This is the practical attitude of expectation. Inasmuch as the two states bring about different results and have different relations to succeeding states, they have not the same function. To determine this in the case of expectation forms another interesting problem.

Expectation an Ideational Process. — Turning now to the analysis of expectation, we observe first that it is an ideational form of consciousness. The ideational process assumes three primary forms: memory, expectation and fantasy, popularly called imagination. All of these forms are dependent on past experience. Memory is the type of reproductive ideation in which the images and their general arrangement is the same as

in the original experience. Constructive imagination stands at the other extreme, as the type of productive ideation in which the simple ideas are recombined in a novel order giving a content which has never been apprehended through the senses.

Expectation stands midway between these forms. All immediate and some of our mediate anticipations are reproductive; but not at all in the sense that they are consciously recognized as repetitions of past occurrences. There is no reference to the past in pure expectation, although it is none the less true that we can not have an immediate expectation of an event which has not been experienced before. In most of our ordinary anticipations, however, and particularly in those of are flective and inferential character, discrimination and construction are present.

When we come to analyze a concrete case of expectation, certain constituents are always found to be present. The first to reveal themselves are related images with attendant feelings. Next we discover sensational concomitants arising from organic sensations. This term is to be understood as including kinæsthetic or muscle and joint sensations, as well as common sensations from various internal organs.

An isolated image can never suffice for expectation. Indeed an isolated image is as much an abstraction from actual experience as a bare sensation is. The unit of conscious experience is the content which can be grasped in a single pulse of attention. Its meaning is always unitary, although its form may be complex. Such a content involves relations as well as terms, both of which come to light upon analysis as part-contents of the total state. The most meager content which has any meaning for us will reveal both images and sensations bearing definite relations to each other.

It is important at this point to recall the differences between sensations or percepts and images, since one characteristic of anticipation is the tendency of the images to pass over into sensations. The two are closely related and rest upon similar physiological conditions. We may say, with Professor Ladd, that they 'differ only in degree of the same essential characteristics.'[1] The characteristics must then afford constant differences in

[1] 'Psychology Descriptive and Explanatory,' p. 241.

degree by which the two elements may be recognized, since we find these serving distinct purposes in consciousness. Hume asserted the difference to be one of intensity only, and referred to the idea as a faint copy of the original impression. This, however, is inadequate to explain the certainty with which, in normal life, we distinguish the two processes. Closer analysis shows that the idea not only lacks the intensity and vividness of the impression, but that it is less stable and possesses a vagueness in the limiting lines and surfaces which deprives it of the perspective quality that marks perception. The duration of the two processes differs also, the time-rate of ideation being more rapid. Again, the image, being centrally aroused, involves primarily the bodily processes which are immediately connected with the central nervous organs; while sensation, being aroused from without, requires, in addition, the well-defined activity of the peripheral sense organs. It may be said, then, that an image is the production from within of a content similar to that which, at a previous time, was introduced into consciousness from without.

But the foregoing remarks seem to apply particularly to sensations and images which concern the special sense organs. The question arises whether there are the same differences, and the same variations in degree of difference, between the sensations and images which pertain to motor consciousness.

Now the line which separates motor from sensory consciousness is largely a practical one. The former is really a division under the latter, coördinate with visual and auditory. The term motor merely describes a differentiated branch of sensations; a branch so distinct, however, both in its function and the source of its stimulus, that it is set off by itself and contrasted with all the others which are together classed under the head of sensory. One broad distinction is the source of the stimulus which in case of the motor activity arises within the body and in all other cases is external to it. There is also some historical justification for the classification, as the nature of the movement sensations has come to light under modern investigation and experiment; while sensations arising from the five special senses have been from time immemorial associated under the common term sensory, or some similar phrase.

But it is the difference in function which to-day warrants the continued use of the terms. The special senses all have objective reference and give information of the outside world; while the motor sensations, including those from the muscles, joints and internal organs, tell us of ourselves, where we are in space, what we have done and whether we have actually expressed our thoughts and wills. It is only through motor consciousness that we know that we are alive and taking part in the action of the world. So we are justified in holding to the two terms; sensory, to indicate the receptive side of mental life; motor, to express the active attitude: the one tells us that something has been done *to* us; the other, that something has been done *by* us.

We now return to the question whether the distinction between sensation and image, which is accepted for the sensory side, will hold equally well on the motor side. How clear and well-defined, it may be asked, is our distinction between our kinæsthetic ideas and the corresponding sensations? Experience shows us that it is no easy undertaking to discriminate between the two. Introspection is often baffled in the attempt. When I imagine the movement of my wrist, for example, the visual idea[1] is prompt to arise. Further than this, I am conscious either of nothing, or of a faint tingle in the joints of the wrist. Again, it is impossible for me to *imagine* how I feel when I hold my breath and at the same time to breathe regularly. Of course one can passively remember or conceive what these processes are. But then, one may be remembering merely the words which stand for the act. Certainly when I try to recollect in an active way the sensation of the wrist movement, the vividness, life-likeness and definiteness of the resultant consciousness are such that I know not whether to call it idea or sensation. The dividing line between the two is by no means so distinct here as in the so-called sensory consciousness. The difference there has been pointed out and the fact noted that in normal experience sensation and image are not confused.

When the difference in function of the special senses and of

[1] In this passage and throughout the section the terms *idea* and *image* are used interchangeably.

the organic sensations is considered, it is clear that there is not the practical need for so sharp a distinction between sensation and image in the latter as in the former case. Sensations fróm the special sense organs give us information of the world that is without us, and it is of vital importance that we should not confuse these presentative experiences with our thoughts and fancies about the same facts. Organic sensations give us information concerning our own organism, and confusion regarding the reality and our ideas concerning it is not fraught with such serious consequences as in the former case. Forms of hypochondria are largely due to illusions in the field of organic sensations.

Another service is rendered by these internal sensations. They are peculiarly the sign of our own active participation in objective events. They identify a sensation as a part of our individual, unsharable experience. The movement of an arm in space which I see, is *my* movement only when the visual perception is associated with certain kinæsthetic impressions. These are the sensations most closely implicated in the knowledge of the self. Now the ideas of these movements, appearing as concomitants of some interesting sensory image, serve just the same purpose and give to the pictures of memory and expectation their personal and life-like setting, establishing them at once as part and parcel of our individual experience.

That special group known as kinæsthetic sensations has another function besides those just mentioned. The movements of muscles connected with the special sense-organs are so insignificant of themselves that they have become mere signs of more interesting facts connected with external perception; as, for example, the sensations afforded by the muscles of the eye in accommodation and convergence, which have become signs of distance and solidity. It is only by an effort that we notice the sensations themselves.

We have seen that the visual reproduction of movement is a simple and unequivocal matter; but that when we try to reproduce our tactual and muscular sensations, we succeed so well that we can not tell where idea ends and sensation begins. Active attention to the idea seems to give sufficient stimulus to arouse the

sensation. Here again, there do not seem to be the same objections to admitting exceptions to the rule that are felt in regard to outer sense perception. Many psychologists are convinced that, in the sphere of perception, an image can never pass over into sensation without the coöperation of an external stimulus. The same view may hold in the case of organic sensations; namely, that attention to the idea does not do the whole work; that the permanent contact of the organism with the environment always affords faint, unappropriated stimuli which are directed by attention into the desired channels. This would be more in harmony with the general theory above referred to. Still, the other view has many advocates. Külpe refers to 'sensations aroused by ideation of movement' as a matter of course, and speaks of the well-known possibility of inducing cutaneous irritation by concentration of attention.[1] The question is, however, whether 'concentration of attention' can mean in such a case a summation of purely centrally aroused activities. It is not difficult to see that the appropriation of incoming stimuli might be wholly unconscious, so that there would be no reference to an objective source. Certainly the occurrence of sensations from joints and muscles often takes place without conscious external excitation.

But what do we mean when we talk of 'external excitation' in the case of organic sensations? Very little is known of the end organs and their appropriate stimuli. Change in the condition of the organ itself is the sole source of the stimulus, and this is always internal in the sense of being within the body. But it is one thing to say that the stimulus to muscular sensation is internal in this sense, and another that it has its source in an idea. Whether an *idea* ever originates the changes of the organism which serve as stimuli, or whether these must depend also upon antecedent movements, is a question which empirical psychology must further investigate. As was said at first, this is only a part of the larger question of the efficiency of ideas as stimuli to any kind of sensation. Such works as Lipp's 'Suggestion und Hypnose,' are efforts toward the solution of the problem. This consideration of the relation of sensation to

[1] 'Outlines,' pp. 327, 434.

image is particularly pertinent to our subject because many of the supplementary factors of expectation belong to this borderland of organic sensations and their correlative images.

All states of consciousness contain both sensational and ideational factors, but in different proportions. When sensations predominate and absorb the attention, and images serve only as a means for interpreting the sensations, the total state is called perception or presentation. When the images are the more numerous, and the faint sensations seem to have no relevancy to the topic in hand, serving merely as a basis for that peculiar sense of one's personal participation in the train of thought, the process is termed representation, imagination or ideation.

An obvious result of ideation is the enlargement of experience. From the purely psychological standpoint, this means an increased complexity of consciousness and is exemplified in the three representative processes, memory, expectation and productive imagination or fantasy. One can readily see how this complexity shows itself in the processes of memory and expectation. In both cases within the total content of consciousness certain part-contents are referred to others which appear to have a greater degree of reality and a remoteness in space and time. In the case of productive imagination there is no reality-feeling connected with the second part-content and it has no temporal relation to the presentation. The unfamiliar arrangement of ideas characteristic of imagination is found in some forms of what has been termed indirect or mediate expectation, but not in the immediate form nor in memory.

Now since the main image may be the same in all these forms, it is evident that the differentiating characteristics of each process must be found in the supplementary parts and in the relation of the whole representative content — be it memory, expectation or imagination — to the immediate sensory factors. In the case of expectation the supplementary part is composed of ideational and sensational factors with their attendant feelings. These concomitants, together with the central idea and the definite time relation to the presentative element, constitute expectation. Attention will be turned first to the ideational and sensational factors, then to the relational element and lastly to the feelings.

III.

The Ideational and Sensational Factors.

Expectation is the incipient response of the organism to the demands of some new situation. It begins in motor reactions to a subjective stimulus which is, in turn, aroused by some perceptual form of consciousness. This is but another way of describing the process which before has been considered from the standpoint of content. What we there called the central image is identical with the subjective stimulus, the essential concomitants are supplied by the motor reactions, while the present situation, embodied in some perception, affords the external excitation of the process as a whole.

The central image is always sensory, that is, of some sensational effect. In immediate expectation it follows directly after the sensation and at once introduces a perception. This, if the anticipation is fulfilled, corresponds to the idea, but in case of disappointment differs from it. In mediate forms of expectation, the sensory image stands at the end of a shorter or longer series of images which serve as links to hold together the presentation and the object of the anticipation. This connection between the present situation and the final sensory image is absolutely essential to expectation. The ideational concomitants are of two kinds: the first, sensory, which give the setting of the anticipated event; and the second, motor, those already spoken of, which give to the content its sense of incompleteness. The predominance of lively motor images, passing over into sensations, constitutes a large part of the difference between expectation and memory. The sensational element in anticipation is furnished by the organic sensations, using this term as before in its widest sense.

The nature of the concomitants, as found in both mediate and immediate expectation, will be clearly understood in the light

of a few examples. Take the illustration used before. Suppose that the sight of a book arouses the expectation of meeting my friend down town to-morrow morning. This is an instance of mediate expectation. The central image is that of the friend; attached to this are images of streets, buildings, people, and vehicles of various sorts. If 'down town' means the town in which I reside, these images are, on the whole, distinct. But this picture does not join itself directly to my present situation. I am obliged to picture various intermediate and connecting links which form a series whose last term is the meeting with my friend, and whose first, is my present situation. The images need not all be explicit. They are symbolized to me by the word to-morrow. In adult life the law of mental economy has brought about this possibility of making a single word stand for a whole train of ideas. Whether it can escape some accompanying imagery is a question. At any rate there is, in this case, the conception of a time-length which might be filled in with other expectation images; if, for instance, my impatience to see my friend should lead me to picture the various events which must occur before his arrival.

As an illustration of a more immediate expectation, take the ideas aroused by hearing a familiar knock at the door. Here the image of a well-known form entering the opened door arises immediately and finds its time-setting in the present situation. Still, this is not immediate expectation, since the well-defined idea of the door as opening must intervene between the suggesting sensation and the anticipated one. But suppose I see a flash of lightning, I expect to hear the peal of thunder immediately after it. The image of the sound arises at once and forms the center of the anticipation. The concomitant ideas which form the time-setting are the same as those of the present situation. Their vividness is the sign of the immediacy of the not-actually-present content. The remaining concomitant ideas are of the motor sort and in this instance, as in all immediate expectation, blend with the organic sensations which are associated with the central idea.

In inferential and all mediate expectation, the motor ideas predominate. All plans for the future come under this head.

But to the motor forms already described must be added those which Professor James calls 'remote images,' those of movements which are to be perceived by eye, ear and skin. These 'resident' and 'remote' images of movement prevalent in mediate expectation stand for the conditions upon which the end, represented by the sensory image, depends. When the anticipated event is familiar and not attended by strong feeling, only those motor images are involved which are associated with the activity of the sense organ concerned in the anticipated perception. When the coming event has uncertain factors entering into it, or when deep feelings are aroused, many of the motor ideas pass over into the corresponding sensations; other parts of the organism are excited, and emotional concomitants are brought into action.

In immediate expectation the sensational factor is always more prominent. Recall the state of consciousness in the moment which follows a vivid flash of lightning. The sound image of the thunder at once arises; the muscles concerned in the movement of the head and neck are active, and often there is a slight involuntary movement. A sensation of strain seems to start within the head and press outward in opposite directions against each ear drum. These sensations are partly due to the contraction of the stapedius muscle, which is an organ for adjusting the ear to the varying concussions of air. The tensor tympani may be active also, but probably this serves the purpose of accommodation only in reference to tones of high pitch. When expectation becomes tense or strained, as we say, the sensational concomitants are more pronounced. In addition to those referred to, others make their appearance; respiration changes, there is a tendency to catch or hold the breath, the pulse beats more rapidly, the supply of blood in different parts of the body undergoes alterations and the temperature rises. Together with all the activity of the involuntary muscles, there is a conscious inhibition of movement in parts of the body not directly concerned in the anticipated sensation. It is evident in such cases that the cognitive aspect is supplied by sensory factors. In bare expectation the presence of the image and its concomitants merely announce the fact that is to be. If attention be aroused,

all its physiological accompaniments will be felt; and where strong feeling is associated with the image, it will induce the complicated and diffused 'bodily resonance' that belongs to emotion.

The activity of the sensational concomitants is well illustrated in genetic study. Little children and animals are often observed to perform involuntary movements which are a necessary accompaniment of some anticipated sensation. The hungry infant watching the preparation of his food goes through with the sucking motion of the lips. Joly, in his 'Psychologie Comparée,'[1] instances the appearance of the saliva in the mouth of the horse at the sight of the fodder. There is also, at the same time an increased activity in the blood corpuscles of the glands. "What is all this," he says, "but the effort of the organism to begin the function of digestion?" It is the external manifestation of mental expectancy. The human adult learns to control many of these overt expressions. But why should not the changes of blood supply, which cannot be controlled, arouse sensations which may function as signs of the approaching sensory activity? In fact, to paraphrase Joly's words, what is expectation but the effort of the organism to begin the suggested activity?

Laboratory experiments have helped to bring out the facts of expectation. They have aided in determining the various concomitants of which we have just spoken, and in estimating the value of expectation in its function of preparation. The experiments have been directed primarily to attention, so that this complication must be taken into account when results are estimated. It is expectant attention that has been the subject of experiment, and this is not the same thing as simple expectation; it must differ just in so far as mere consciousness differs from attention. However, expectation is no more open to misconstruction on this account than any other process. The close consideration of an object of perception introduces undesired elements which are recognized as a source of error in experiment. Laboratory investigations of illusions have also thrown light on the nature and results of expectation. But this subject will be taken up later.

[1] See p. 70.

IV.

The Relational Factor.

Account must now be taken of the connection between the factors just described and the presentative element that enters into every state of consciousness. This connection is what we come ultimately to call the temporal relation. The difference between our ideas of the future and the past must here be considered, and also the question how these ideas have arisen.

In the first place, beginning the analysis with the content side, the ideas which stand for past and future assert themselves with a certain degree of reality. From the same standpoint, we may say that, psychologically, present time belongs to that part of the psychosis which seems most real. In all these cases 'reality' attaches to that portion of consciousness which resists, opposes the assimilating activity, and which stands apart from — over against — the main stream. In sense perception such a portion of consciousness is termed the object, and the lively activity which its opposing presence induces upon the quieter flow antecedent to its appearance, gives the experience of present reality. In much the same way the representative or ideal realities stand over against the remaining portion of the stream. As they lack the full quality of presentness they are termed absent realities and are differentiated into past and future.

Presence and absence have the same relative significance in their reference to reality that sensation and idea have. The recognition of this difference of reference gives us a basis for the idea of time. It is soon found that while the presence idea, the now, is simple, that of absence is complex having a double reference whose impression on consciousness is very different in the two cases. The absence idea, which later is known as future reference, is strenuous and imperative in tone, having a direct practical bearing on the present; while the feeling of

absence in reference to the past is contemplative and carries with it no demand for action on our part. This distinction between now and not-now is soon followed by that of before and after, indicating the two relations in which the not-now may stand to the now. Can we discover what determines these relations? It can not be mere association, for this only secures the coherence of ideas so that a number of them can be revived on the external excitation of only one of them. If the ideas of before and after are not already in the group, what can association do about it? The process which gives rise to our ideas of past and future is rather one of discriminative attention, manifesting itself from the very first and depending on present interest. The time-direction in revival may follow the movement of attention in the original experience, or present interest may completely reverse the order. We can again make use of our old illustration. The book lying on the table suggests the image of the friend according to the law of association. But this law has no power in itself to decide whether the image shall take its place before or after the present experience in the train of ideas. The image has of itself neither past nor future reference. This discrimination is the result of the activity of attention and, we repeat, is decided by present interest. A letter, recently received, announcing a visit from the friend, would throw the image forward. At first, intensity of content is sufficient to attract the attention and direct the time order. Later, interests more or less remote come in to influence the movement.

It is somewhat difficult to characterize the difference in the activity of consciousness which marks time as past or future. From the standpoint of attention such a distinction arises from its unequal distribution between percepts and ideas. Consciousness can not attend to its contents as a simple whole, so they fall apart into two or more groups. Certain obscure, ideational elements will not assimilate with the present sensations and are grouped together as having reference to something not now present in consciousness.[1] Attention is divided between these part-contents so that it must go from one to the other. Memory and expectation are ideational part-contents of a complex containing both ideas and percepts.

[1] Compare Wundt, 'Outlines of Psychology,' Eng. trans., p. 241.

If now we illustrate the process by symbols, *abcD* would represent the memory process in which *D* stands for the perception of the book and *c* for the image of the friend. The expectation process would be represented in this case by *Dcef*; *ab* and *ef* standing, in the respective cases, for the varying circumstances.

Whether an idea shall be placed before or after the present impression which serves as a suggestion, depends upon the relative amount of activity excited by percept and idea. If the concomitants of the percept *D*, that is, the images and attendant organic sensations and feelings, assert and maintain themselves in the face of the idea *c* with its concomitants, the result is expressed as *abcD*. If, however, the concomitants of the percept are opposed by the vivid motor images and strong counter organic sensations accompanying the idea, so that attention in its vibrations between percept and idea tends to center upon the latter, increasing its force and active value at the expense of the former, we have a process of expectation which is expressed as *Dcef*.

According to this analysis, then, the ideas of time-direction have their origin in the decreasing and increasing force of attention in its movement between percept and image. The variations of attention accompanying a series of percepts would give merely an experience of sensation and duration; but an idea of time in its three directions requires representation as well as presentation. It may be objected that attention often passes with strong force from a suggesting perception to an ideational content which is not expectation but memory, as when one is reminded of some very interesting fact. This is true; but when it happens, the time idea is lost; attention ceases to vibrate and fixes upon the memory. If at any moment we consciously think of the experience *as* past, we at once introduce another factor, and the process above described will take place. We shall have occasion to return to this objection a little later.

A few concrete illustrations of the genesis of memory and expectation will emphasize their characteristic differences. In child-life the earliest anticipations arise doubtless in connection with the feeling of hunger. Genuine expectations are aroused

by seeing the preparation of food. Here the attention steadily bears away from the present experience to the idea of the nourishment which will bring satisfaction. Just as the persistence of the after image is the rudimentary form of memory — the effort of the mind to hold on, as it were, to some interesting image — so primitive expectation is the insistence of what may be well termed the fore-image, the effort to get again a sensation previously experienced. It is, as Lipps says, 'das Verlangen der Vorstellung zur Empfindung zu werden.'[1]

This is well shown again in an instance which Sully gives to illustrate the inception of memory.[2] A child is watching the play of a sunbeam on the wall. Suddenly a cloud passes over the sun, leaving only the uninteresting wall paper as the sole, immediate presentation. The sunbeam image, however, persists and because of its interestingness attracts the attention. So far, surely, the image refers neither to past nor future.

What happens next? If it declines in 'intensity and distinctness while the actual presentation persists intact and so gains in force relatively to the image,' as Sully supposes it to do, then the process is one of memory.

But as a matter of fact, would this be likely to happen? Would not the image rather *insist*, and almost vie with the dull wall percept in vividedness? The child *expects* the sunbeam to reappear every minute, as the active attention with which he watches the blank wall indicates. If the expectation is not fulfilled, after a little time the image begins to decline, and then may well follow all the memory characteristics. Suppose the sunbeam should return after a moment. Would it not come to the child as fulfilled expectation rather than as a new sensation or an unexpected recognition? The child-mind naturally turns forward; it is prospective rather than retrospective.

When a sequence of percepts is many times repeated, the order tends to become established; and, in the absence of strong, conflicting associates, the reappearance of the later percepts will serve to suggest the earlier ones, resulting in the memory form of consciousness; the reappearance of the earlier

[1] 'Grundthatsachen des Seelenlebens,' p. 667.
[2] 'The Human Mind,' Vol. I., p. 321.

also tends to suggest the later. This may result either in memory or expectation. Circumstances may inhibit the concomitant motor ideas which are essential to expectation, and leave the content with the memory marks. If I have had a repeated experience of a characteristic knock at my door followed by the appearance of a person whom I seldom see elsewhere, the sight of this man in another place will probably recall the knock and the opening door; but the knock will not in every instance arouse the expectation of seeing the door open and the friend enter. If, for instance, instead of being in my own room I am in a strange place and know my friend is far away, the sound of the well-known knock does not arouse the expectation of seeing him enter. I merely judge the knock to be like his, to have a familiar sound. The image, which of course arises, does not have the concomitants of expectation but those of memory. It is quite possible that for an instant consciousness may take the expectant form; but other ideas will immediately inhibit this, leaving only the possibility of memory. Such experiences frequently occur when we think we hear a familiar voice in a strange place.

This study of the origin and nature of our differentiation of past and future justifies the statement that, in addition to the ideational and sensational factors in the content of expectation, there enters in another element, a relation between the impression and the ideational factors depending on the distribution of attention, which is ultimately known as the time relation. The conflict between the presentative and representative part-contents of consciousness is resolved in the idea of succession wherein the most intensely felt content is termed the present, and that part of the remaining content which, because of its practical interest, tends to issue in a like intensity in its turn, is called the future. The ideas which have reference to this content form expectation. In primitive consciousness attention involuntarily moves toward the point of greatest immediate excitation; but later it may be voluntarily directed according to interests more or less remote.

The Historical Genesis of Expectation. — It was impossible to speak of the nature of the time relation in expectation

without also giving some account of the genesis of the process itself, since its essence lies in the future reference. That account, however, pertained wholly to psychological origin. It remains under the present heading to point out, if possible, when, in the historical development of consciousness, expectation appears and what relation in time this appearance has to the earliest manifestations of memory.

Genetic study must give the final answer to the first question; but it may be approached from the theoretical side. After-images are the sensuous basis of representation. A little later images proper and ideas develop. In so far as these do not fuse with sensation they come to have a distinct significance. Part of this significance is the reference to future events. The question then is: How early in the life of the child does developing consciousness refer these images to future events? Upon the theoretical side the answer is: As soon as an act has been repeated times enough to establish associations between different sensory stimuli and to coördinate sensory and motor elements so that the child can react to an excitation, thus carrying on the work which the stimulus has begun. This reaction is the expectation of primitive consciousness. Turning now to the practical study of the infant mind, some interesting observations recorded by Lehmann may be given.[1] The child who was the object of his study gave its first manifestation of expectation when twelve weeks old. At this time it was noticed that when the child caught sight of his nursing bottle he began to make the sucking movements with his lips and to strike out with his arms. The latter movement was doubtless of the general, undirected sort which precedes that of the specialized order. But the movement of the lips was evidently the result of coördination with the visual stimulus. When the bottle was removed the child began to cry. This looks like disappointment, but we must not assume too much; mere unsatisfied hunger might cause the cry. Two days later, the account goes on to say, the child smiled at sight of its mother and displayed evident signs of recognition. According to Lehmann this indicated a previous activity of expectation, as he believes that recognition presup-

[1] 'Die Hauptgesetze des menschlichen Gefühlslebens,' p. 313 f.

poses a primitive form of expectation which he describes as 'the mere reproduction of an idea which in the next moment will be compared with a perception and be found identical or not.'[1] Expectations of the unpleasant kind, or fear, were observed about the thirteenth week.

From the nature of the case no equally early appearance of memory could be recorded. Recollection images would not, of course, suggest outward movement, so that their presence could not be inferred until much more complicated actions took place, even if they existed for consciousness. So the study of the relative date of the appearance of the two processes cannot be decided upon external data. We are obliged to return to theoretical considerations. What, then, are the grounds for determining the antecedence of either process? Take first the argument for memory, as that presents the more common view. An advocate of this view might say: Expectation depends on past experience for all its materials. The images which it uses are the results of previous mental activity. But memory only can recall past experience to the mind. Now in order to know how to make use of this experience in preparation for future action, we must first remember it. Therefore, memory must appear in consciousness before expectation.

When this argument is closely examined it shows some confusion in the thought. The words memory and remember are ambiguous, and it is not clear just what 'we make use of'; it is implied that we can not use ideas until we are conscious of the fact. Now what 'we make use of' are merely the effects of past experience, and these effects are what we call images and ideas. The words memory and remember can be applied correctly only to events which we know to have occurred in our own personal past, so that to *have* ideas and to *remember* them are two distinct acts. It has been shown in the analysis of the time relation that consciousness must make use of images in connection with percepts in order to gain any idea of the past as past; so that, as a matter of fact, we do use our experience before we remember it, that is, locate it in the past. Consciousness knows its own contents long before it knows what condi-

[1] *Op. cit.*, p. 231.

tions them. So it recognizes the *meaning* of the images which appear there, before it knows that they are the effects of past experience.

Cornelius, in the book already spoken of, maintains it to be essential to the very idea of succession that the effect of past experience be recognized immediately as effect. It must possess a "symbolic function according to which we immediately mean it as a sign of a past experience which on its side is distinguished from the sign of the present. This symbolic function of the memory-image is that on which the difference of present and past is conditioned and with it the knowledge of the temporal course of our life."[1]

Such a theory does not provide for the origin of our idea of the future. If the differentiation of present from past depends upon an image which, being the effect of past experience, must always function as a sign of the past, what is the basis for the differentiation of present from future? There is no introspective evidence of any double reference. When an idea refers to the future, it *means that at once*, and nothing but that. If we chance to recollect that this same image has been a part of our past experience, such a reference is a distinct act of consciousness. If I am expecting to hear the clock strike I do not at first recognize the sound image as a past experience, and then, finding a certain feeling attached, know it as an anticipation. When Cornelius comes to define expectation he speaks of the memory-image (Gedächtnissbild) as 'a common symbol of the past and of the new experience.'[2] In general he uses the word memory-image to mean just what has been implied in the term image in these pages, which hardly seems consistent with the explicit statement of the passage quoted above. If, in that passage, the word *absent* were substituted for *past*, so that the sentence would read, '* * * according to which we immediately mean it as a sign of an *absent* experience which on its side is distinguished from the sign of the present,' it would exactly express the view here given.

It is impossible to make the idea of the future the same as

[1] 'Psychologie als Erfahrungswissenschaft,' p. 23.

[2] *Op. cit.*, p. 88.

that of the past with only a difference of feeling added. Nor does the fact that both depend on past experience make it necessary that this should be a conscious fact in the case of the future, thus requiring the antecedence of memory. Rather does such a theory appear to be a case of psychological fallacy. The man of mature mind knows that past experience is necessary for expectation, so it is taken for granted that consciousness must recognize that it has undergone a particular experience in the past before it can anticipate a similar one in the future. If we are fair to facts, we must certainly give up the idea that an image *per se* has a past reference.

Two or three considerations may be suggested in support of the opinion that expectation antedates memory.

In the first place, let any one reduce his own consciousness to as nearly a primitive state as possible, bringing it into a perfectly quiescent and passive condition. Now let some idea be suddenly suggested and it will be noted that the tendency, though it may be quickly inhibited, is in the line of expectation and not memory. Consider again the earliest manifestations of child thought. The little one is so on the alert that it is much more natural to infer expectation than memory from his actions. When the mother says, 'gone — gone,' the child immediately looks around, indicating that the idea of coming again is the one aroused. Watch him play peek-a-boo; there is no doubt there that the ideas are of the anticipatory sort.

Now let it be asked, What is the biological reason for the development of the image? Is it for the sake of affording the creature the opportunity of living over his past experience, or of enabling him to pre-live it and thus prepare for more complex situations? The latter is the only rational view. The earliest reactions in the developing consciousness would be for the preservation of the organism, so that primitive ideation would be forced into the prospective form. Nature would further the development of any organ that would be of use in the struggle for existence. Through the association of ideas, which of itself, as has been said, contains no time reference, past experience, without any conscious recollection, would serve as a mechanical guide to action. The cravings of hunger

would impel the animal to seek for food, the scent of the prey would guide in pursuit, and appetite would be satisfied without any retrospection whatever. There is probably very little genuine recognitive memory in animal life; that is, conscious reference of representations to a definite time in one's own past. Most of the actions of animals popularly attributed to memory are doubtless due to expectation.

When, then, it may be asked, does the memory-process begin to work? Höffding suggests the answer in the following passage: "Life struggles forward and is only moved to look back by experiencing check."[1] Expectations are disappointed and desires unsatisfied, and these experiences teach that not all images can be realized in the repetition of the original sensation. Some of them soon come to have the significance of 'no-more,' and constitute our past for us. Consciousness soon learns to detect the differences which accompany these common images and to give them their proper reference without hesitation.

With these various considerations in mind, the conclusion is pressed upon us that expectation is a more primitive form of ideation than memory.[2] But a precedence of this kind is limited only to the lowest and most primitive stages of consciousness. No rational action would be possible on such conditions. For this, reflection and comparison are necessary, and these involve memory. Images must be divested of their active form and regarded from the more passive standpoint of completed action if grounds and motives are to be discovered and used as conscious conditions of future action. The memory ideas would not lag far behind those of expectation in their development. The organization of the past must go hand in hand with that of the future for all rational beings.

[1] 'Outlines of Psychology,' p. 134.

[2] Compare 'Illusions,' by James Sully, p. 300.

V.

The Affective Tone.

It is generally agreed that expectation has no specific affective tone. By this is meant that it is not intrinsically pleasant or unpleasant; it may be either the one or the other. When we come to inquire just how the affective tone is connected with the intellectual side of the process, we find this relation somewhat complicated. The difficulty comes to light in the twofold statement of the problem.

It may be asked whether expectation is pleasant or unpleasant; or, whether expectations are pleasant or unpleasant. The two questions must be considered separately. They may be distinguished provisionally as referring respectively to the act or process, and to the object or content. By content is to be understood the central ideational factor towards which attention naturally turns; while the process rests on the movement of the sensational and relational factors. This distinction is ignored in our common use of the term. We usually have in mind the concrete contents when we speak of the pleasantness or unpleasantness of our anticipations. But further analysis shows that this affectively toned object is really only a part of the total state of anticipation which we have already analyzed, being that part which consists of the sensory images. This is about all that is taken into account when we talk about our anticipations. Whether, from this standpoint, an anticipation is pleasant or unpleasant depends on previous experience.

The act or process has reference to the motor disturbances due to organic sensations involved. These sensations have their affective tone, which may also be agreeable or disagreeable. The complication of matters is increased by the fact that the affective tone of process and that of content may agree or disagree. If they disagree, however, the resultant tone is not a

mixed one, but takes the character of the stronger quality, whether it pertain to ideas or to sensations.

The organic sensations most constant as concomitants of expectation are those of strain due to the activity of the muscles and joints in adjusting the organs for the coming sensation. A certain intensity and duration of these sensations affords a stimulating pleasure, while an excess will have the opposite effect. So we have a complication in which an agreeable strain of expectation may be associated with the idea of a disagreeable event; or a painful strain may accompany the idea of a delightful occurrence.[1] Think of the mixed feelings with which you may anticipate hearing the opera of Tannhäuser, If you are very fond of music, the general feeling is one of pleasure. If you have not heard a good performance for some time and are going with congenial company, this will increase the activity of the motor concomitants, giving an agreeable degree of strain which will heighten the pleasure. But if you are weary or have a headache, or are sated with music, or have uncongenial company,the heaviness of the sensational concomitants becomes so disagreeable that it overbalances the pleasure of hearing the music, and the anticipation is, on the whole, unpleasant. If the attention can be turned from the sensational characteristics and fixed on the music idea, the pleasure-feeling associated with this may gain ascendence and give its color to the total anticipation.

From these facts it is impossible to determine whether, on the whole, the process is pleasant or not. In a normal, healthy condition of the nervous system, it seems as if the activity of the strain sensations would be agreeable. In answer to questions put to a number of persons in regard to the nature of their feelings connected with expectation, it was evident that in most cases there was no distinction made between the affective quality of the central idea and that of the concomitants; they were lumped together, except in the case of intense and prolonged anticipation of pleasure, which was admitted to be unpleasant. Two persons, however, said that for them expectation was never wholly pleasant, no matter how delightful the event; so long as

[1] Compare Külpe, 'Outlines of Psychology,' p. 328.

they were obliged to look forward to it, they were distinctly conscious of an uncomfortable and even disagreeable feeling. Doubtless there was an excess of strain sensations in their cases and this seemed to be the normal state of anticipation for them. On the other hand, I found two persons who reported that they found pleasure, at least sometimes, in the expectation activity when the event was wholly disagreeable. The feeling was observed after a certain monotony of experience found in a routine of habit or the state of *ennui*. This has the unpleasant tone, because there is a general lack of motor activity throughout the organism, and if the attention be aroused by a prospective idea even though in itself unpleasant, yet the total activity has a real pleasure-tone. This is Mr. Marshall's idea in contrasting expectation and non-expectation.[1] The state of *ennui*, both in its feeling and cognitive aspects, comes nearest to non-expectation. Here the prospective life is at its lowest ebb, the images all have the color-tone of the present experience which seems to drag out its length in a monotonous, interminable *Now*. Time has lost its forward movement and is swallowed up in pure duration.

It has been said that expectation has no constant affective tone. But must it always have some quality of feeling connected with it? Can there not be anticipations which are neither pleasant nor unpleasant? Certainly. Just as many habitual experiences of daily life have no marked affective tone, so the anticipations of such events can not be called either pleasant or unpleasant. The teleological explanation is the same in both cases. Any content which has a decided affective tone will attract the attention, and it is essential for attainment of further ends that emotional interests originally connected with acts which have become purely instrumental should not obtrude themselves. Habit depends on the possibility of such a separation, since it is in essence action without attention. There is, of course, no act to which attention may not be called and feeling-tone thus aroused. So too with expectations; if they are reflected upon and set forth in relation to other possible events, the pleasure tone or its opposite is readily induced; but

[1] 'Pain, Pleasure and Æsthetics,' p. 235.

it may not be that of the original experience. An unpleasant occurrence may be recalled with feelings of pleasure and amusement.

The freedom and readiness with which ideas and feelings may associate and again be separated from each other, is shown in various ways. Different feelings may attach to the same anticipation at different times or with different individuals. The expectation with which a child and his parent look forward to a day at the home of a friend is the same in both cases so far as the central sensory image is concerned; but this is attended by different feelings, and all the concomitants with their attendant feelings are different. Also, in the child's case the expectation is vivid and probably strained; the images are constantly obtruding themselves into the occupation of the previous hours. The parent, to whom such experiences are common, merely regards the expectation image as representing an end in reference to which his actions in the meantime must be directed. Little or no feeling is experienced in the matter. In the same way, a man of active temperament and accustomed to a life of change merely uses such images on ordinary occasions as guides to action, without attaching any affective significance to them; while one less accustomed to change or of an emotional type will consume mental energy in the feelings which are aroused by his anticipation, whether agreeable or otherwise.

Mr. Bradley says that 'an idea tends to realize itself without pleasure or pain.'[1] That is, in normal conditions the mere process of expectation (content is here ignored) has no constant affective tone.

Not all psychologists accept this view, however. Lehmann expressly says: "Expectation is that unpleasantness which arises from the nonconformity (Widerübereinstimmung) of a sensuous image and an image of fancy."[2] He gives as an illustration the expectation of meeting an acquaintance at a definite place, and says that "the disagreeableness of the expectation consists in this: that the imagined picture does not correspond with reality. We suffer continual disappointment when

[1] *Mind*, No. 49, p. 17.

[2] 'Die Hauptgesetze des menschlichen Gefühlslebens,' p. 340.

we compare our sensuous perception, that is, the place without the man, with our imagined picture. The unpleasantness of expectation, of disappointment, will only be canceled when the man actually comes. The identity of the image with the reality will then be a source of pleasure."[1]

This account apparently resolves all expectation into disappointment. But when disappointment takes place, expectation as such has ceased to exist. In identifying the 'image with the reality,' we are comparing perception with a distinct memory-image which represents what we *formerly* expected; but there is no longer any reference to a future reality, hence no expectation. The fact that disappointment, which has only a present reference, is unpleasant, is no reason for concluding that the antecedent process, which has a future reference, has the same feeling-tone. In another place Lehmann compares expectation with recognition, saying that the process is the same, only in expectation it is more conscious and there is a longer time between the appearance of the image and its identification than in recognition. Here he seems to confuse expectation with its fulfillment. Certainly if he holds, with most psychologists, that recognition is in itself pleasant, he would have to make expectation pleasant and thus contradict himself.

He recognizes the distinction between the content and the process, and maintains that, while the latter is always unpleasant, the former has no constant affective tone; when accompanied by pleasure it becomes hope, and when by pain, fear.[2]

Can Feeling be Anticipated?—Passing from the consideration of feeling as involved in anticipation, the interesting question arises whether feeling can be the object of expectation. Can we anticipate feeling? We talk about expecting to feel happy or sad, expecting to have a good time; what do such phrases mean? They take their place, of course, in the same category with the expressions, 'I *remember* how I felt'; 'I *imagine* I shall not enjoy it.'

According to the analysis given, expectation is an ideational process, and ideas belong to the intellectual aspect of conscious-

[1] *Ibid.*, p. 231.
[2] *Op. cit.*, p. 312.

ness, and cannot be carried over to the affective side. As Professor Ladd pertinently asks, "What sort of a psychosis can the 'idea of a feeling' possibly be?"[1] We can no more have an idea of a feeling than we can have a sensation of a feeling. Recollection and expectation being classed as intellectual processes, we cannot properly say that we recollect or anticipate an affective experience. We may, of course, remember or anticipate an idea and at the same time re-feel the pleasantness or unpleasantness which we formerly associated with it.

A feeling, however, may be represented if not ideated; that is, a present feeling may stand for an absent feeling, past or future. There can be no objection to speaking of the representation of a feeling either pleasant or unpleasant, provided we are careful not to think of representation as meaning the same as ideation. All ideation is representation; but there is no reason for limiting the latter term to ideation. On the cognitive side the word presentative is applied to those elements which are aroused by an external stimulus, and representative, to those which are aroused by an excitation from within. Now since there is the same difference of source on the effective side, the same terms may be used, and feelings aroused by an external stimulus be called presentative and those aroused from within, representative.

Some psychologists think that this difference in source affords the best basis for terminology for both cognitive and emotional elements, and so speak of peripherally and centrally aroused sensations rather than of sensations and ideas; and of peripherally and centrally aroused feelings. The latter terms are certainly convenient and avoid all difficulties arising from the fact that we have no single word in the emotional sphere that corresponds to idea in the intellectual. While the terms peripherally and centrally aroused feelings correspond in general to sensuous and intellectual feelings, the former terminology will not arouse some of the prejudices which are associated with the latter, and is preferable for that reason.

There is another way in which the revival of feeling is different from that of sensations and ideas. Different sensations oc-

[1] 'Psychology Descriptive and Explanatory,' p. 251.

curring in the same experience are associated and form a series, so that the recurrence of one will suggest the others. Feelings do not associate in this way, so they can not be recalled nor anticipated as ideas can. For example, the whole performance of an opera may be recalled by hearing a single strain of music. But feelings cannot suggest each other in this way because they have not the requisite independence. Just make the effort to distinguish between the pleasure felt in hearing the music of the opera and the pleasure felt in watching the action; their difference is not at all comparable with that which holds between the two sensations. If the pleasures are abstracted from their respective sensations, what becomes of them? They immediately fuse. They do not remain distinct and become associated in a series of pleasures any one of which may serve to suggest the others. Feelings, apart from ideas, cannot associate any more than volitions can or than one state of attention can become associated with another. Ideas 'attented to' together become associated and suggest each other; but the 'attentions' bestowed upon them do not form a series and serve as a basis of recall. Attention and feeling are too subjective to be treated in this way. Attention is one, although distributed over several ideas; so pleasure-feeling is one, although distributed between various sensations and ideas.

It is this peculiar psychological nature of feeling which utterly refutes the Hedonistic doctrine that pleasure is the supreme end of action. Mere pleasure, apart from an idea, can not be an end at all because we can not anticipate it.

What then is the psychological process involved when we speak of an 'expectation of great pleasure'? It consists of an image together with a pleasure-toned feeling which is like the feeling that has previously accompanied the sensation for which the image stands. It should be added that the pleasure-pain feeling of an expectation just as much *represents* that of the realization as an image represents the coming sensation. To anticipate a feeling either of pleasure or pain, can only mean to experience that feeling in connection with an idea having a future reference. But it must be immediately added, as above, that in this case the pleasure feeling is truly representative in

that it is not regarded for its own sake, but for that of the still unrealized feeling for which it stands.

It follows from this that feeling must depend on ideas for its time-direction. It was found in the section on time relations that the first requisite for time distinctions is the simultaneous presence in consciousness of both percepts and images which must be clearly distinguished from each other. Evidently, feeling can come under no such conditions. In the first place, there are no such criteria for distinguishing between peripherally and centrally aroused feelings as are manifested in the case of sensations and images. A sensation in normal consciousness always has greater intensity than an image; but the reverse is commonly true in regard to feelings. Those centrally aroused are often more intense than those peripherally excited.[1] This is a fact important for ethics and æsthetics and for the development of all the higher qualities of mind. For the present discussion it is important in showing that we can not depend on feeling for time reference. A centrally aroused feeling is just as likely to have a present reference as a future or past one. The time mark belongs to the intellective factors to which the affective tone is attached. If ideas which are attended by pleasure feelings have no reference to either past or future, it means that we are enjoying our own reflections. If they have a future reference it means that we are anticipating a pleasant experience.

An illustration of the dependence of feeling upon ideas for time distinction is found in those feelings, either agreeable or disagreeable, which we sometimes have when we can assign no cause for them. Occasionally upon awaking in the morning, although all immediate presentations have the pleasure tone, there is present also an unpleasant feeling for which there is no apparent cause; that is, no idea to which it can be attached. We call it vague and undefined just because the attendant idea is lacking, for the feeling is itself perfectly defined. Notice how timeless it is; one can not say whether it belongs to a memory or an anticipation. Suddenly there flashes into the mind the thought of an event to take place later in the day, and

[1] Compare Külpe, 'Outlines of Psychology,' p. 226.

to this the feeling immediately attaches itself. This is a case where the motor concomitants and their affective tone are aroused before the main sensory image of the expectation comes into the focus of attention.

It often happens that anticipation is much pleasanter or more painful than the reality. This is another evidence that centrally excited feelings may be stronger than those peripherally aroused.

VI.

The Forms and Function of Expectation.

The Forms. — Expectation was characterized in the beginning as immediate and mediate. The former covers all cases in which the idea at once introduces the sensational experience for which it stands; the time and place concomitants are furnished by the present situation. In the mediate form of expectation, the idea to be realized stands at the end of a series of images and the time and place concomitants are suggested by the final image.

Mediate expectation may again be divided into two forms: the reproductive, in which the ideas and their arrangement are familiar, the latter conforming to the order of the original experience; and the constructive, in which the order of the ideas is unfamiliar.

Immediate expectation is the primitive form. The child is just learning to discriminate the simplest part in the 'big blooming, buzzing confusion'; sensation and image, 'now' and 'not-now' are about all that he can manage. Experience is too limited to afford any perspective for events; there is no standard for a measurement of time. The child's future is wholly unorganized. The divisions of time — year, week, day — are indistinguishable to him; to-morrow stands for all future. Any idea suggested to him naturally takes its place in the forefront of coming events. If his mind is full of the anticipated pleasure of a drive which has been promised to him 'this afternoon at three o'clock,' he runs many times to his mother with the questions, 'When will it be three o'clock? Isn't it afternoon now?' To the child at this stage immediate expectation is the typical form.

Gradually the train of ideas becomes established, and the time-sense better developed. Instead of the immediate sequence of the sensory image upon the suggesting sensation, a number

of links come in between the two, and mediate reproductive expectation begins its important work. Most of our habitual expectations are of this class. Many of them become fairly automatic, serving as aids to thought and volition, but not demanding attention for themselves. This kind of anticipation passes easily over into the constructive form in which the process is only partially dominated by association and the order of ideas is not wholly familiar. No distinct line can be drawn between the two.

The essential thing in constructive expectation is the introduction of only those images which have a relevancy to the present situation. In childhood, before the different forms of the representative process are clearly defined, the images of memory, fancy and expectation are often confused. The free images of fancy are frequently placed in the expectation series. Now this is what we do deliberately in later life, but on rational grounds, in order to form ideals and plans for action. But it takes a long time to organize one's experience rationally. One of the important things to learn is the difference between imagination and expectation. In the former, fancy has free rein from beginning to end of the series; there need be no bond of connection between the picture and one's personal experience. In expectation this is not so; the personal experience element can never be lost sight of. The reality feeling depends on the relevancy of the train of ideas to the present situation. This is well illustrated by the recurrence to the mind at various times of an event expected to happen in the distant future. No matter how circumstances change, an anticipation to be maintained must hold its relation to the present sensuous experience. Whenever the final image of a previous prospective series occurs to the mind, present circumstances must have a place in the chain as it now appears, whether they were originally included or not; that is, we must always be able to reconstruct the series from the present as starting point. If at any time this relevancy disappears, then the expectant idea vanishes; that is, it vanishes as expectation; it may linger as a desire, a memory or a mere fancy image cherished as a bright dream; but its reality-feeling, and hence its value for expectation, is gone.

This, then, is essential to constructive expectation; every idea introduced into the series must appear to have an organic connection with the present situation.

There is no sudden leap from the reproductive to the constructive form. In fact there are not many habitual expectations into which new elements are not introduced. Take as an illustration my expectation of meeting my class at half-past ten to-morrow, aroused by seeing some partially prepared notes on the table. The idea with which the series ends is familiar, and so are most, at least, of the intermediate steps. The process may be quite mechanical, but it is not necessarily so. It is quite possible that there may be in the train of ideas certain images which have not been associated with the regular members of the series upon any former occasion. For example, I may know that two new students are coming into the class; or that the exercise is to be held in another room. These facts must be taken account of. To be able to insert such ideas into the train of thought without interfering with the integrity of the anticipation process is to be 'mentally productive,' as Mr. Stout says. Something more than mere association is at work here.

So far only those cases have been considered in which a single series of images is concerned. It is evident that to have a train of ideas function expectantly, conflicting associations must be inhibited. So long as these remain, doubt is present and at best expectation vacillates, passing with the attention from one to the other of the possible courses of action represented. This renders necessary some other factors to help resolve the conflict. The same principles that in memory determine which of various possible associates shall be evoked, are active in expectation. If I am told that 'a friend' will call upon me on a certain day, my expectation is necessarily indefinite. Various associations have been established with the word friend. Many of them will arise; what ones, will depend on the so-called secondary laws of association, the frequency, recency, and impressiveness of previous combinations, or the harmony of the suggestion with the general tone of feeling. Some of these will be promptly inhibited by their incongruity with present circumstances, and these circumstances together

with subjective interests will keep others in the field. 'It can't be A nor B,' I say, 'It may be L or M; but I think it is N.'

If my experience with the going and coming of friends is extensive, the mere announcement of a friend may not call to mind any particular individual. In early stages of mental development, the tendency to particularize is strong. The youthful and untutored mind is usually quite specific in its expectations. The child seldom hesitates to respond with perfect definiteness to the remark, 'Guess who is coming to-morrow?' For the experienced and well-disciplined mind it is possible to inhibit any definite, pictured pre-perception and maintain only a sort of indefinite expectation, which might be described as generic in contrast with the particular form of the above example. Such a mental attitude is desirable, since it saves the mind from shocks of surprise and disappointment which are constantly besetting the person of the more imaginative type. Still, abstract anticipation is not easily attained. For the most of us there would be an image of some sort; but doubtless it would be less of the concrete and more of the generic kind, awaiting development into any one of a number of particular forms.

Sometimes, however, it is essential that the different series should be concretely formed and that the mind should choose between them; as, for example, when it is desirable to make different preparations for the different friends suggested. Here there must be a comparison between the suggested ideas, a weighing of conditions upon which they rest, and the most probable train of ideas then becomes the expectation. But when we try to explain what is meant by the probable in relation to expectation, we appear to be treading in a circle. We expect that which is most probable; that is most probable which is most strongly expected. Whatever we expect must be probable for us. A low degree of probability is expectation mingled with doubt; a high degree is unmixed expectation. The two are really different views of one fact or experience. They are related in much the same way that attention and interest are; or as secondary qualities are related to sensation. Probability is expectation objectified, just as color is sensation objectified.

Popularly, color is attributed to objects; in like manner probability is popularly attributed to events. When, then, it is said that any event is highly probable, the implication is, first, that there are other possibilities, and, second, that because of certain rational grounds, this one is regarded with unmixed expectation.

Constructive expectation sometimes involves inference. In such a case the intermediate ideas and the final image are distinctly held apart and their connection as ground and consequent is recognized as a necessary one independent of the present individual experience.

This account certainly differs from our previous descriptions of the process. It is true that in its primitive form expectation is of the nature of habit and passes from inception to conclusion without regard to reason; it is non-rational, often irrational. Again, it always retains the individual and personal form; its conditions are some phase of self-activity, while the conditions of inference are universal. If, then, we are to have inferential expectation, the original process must undergo a change. The result shows what might be termed a compromise; expectation gives up its non-rationality, and inference, its impersonal form. Anticipation passes at once beyond its mechanical stages. It interrupts the mechanism to regard itself in an objective light, to discover conditions and draw the inference and then resumes its own intrinsic work by reëstablishing the connection between the present personal state of consciousness and the final sensational effect which is now the inferred conclusion. Let us trace this process more in detail.

In the first place, it must be remembered that inference is not based on particular, concrete cases, either one, two or a hundred of them; but on underlying conditions which are not only manifested in this instance, but are believed to exist and manifest themselves in the same way outside of this particular experience, and, perchance, apart from all individual experience. At first this seems to conflict with expectation which must have its basis in the repetition of similar instances. But we have found that this is only part of the truth, and that there is an element of productiveness in anticipation which well provides for just such a possibility as introducing general conditions into particular experiences.

The same result may stand in the relation of a reproductive or inferential expectation. I may anticipate a misfortune because I have experienced it before, or, because, without any such experience, I discover in my present situation the conditions which, anywhere and to any one, would bring about this misfortune. In order to pass from one to the other class, rational, that is universal grounds, must be introduced. Take another illustration. I should reproductively expect the reappearance of a man at a certain hour whom I had observed to pass my door at that time for several weeks. There would be no inference here. The expectation could become inferential only after further investigation had shown facts which could serve as uniform conditions of the man's appearance. I might discover that he was in the service of a well-established business house which employed only steady-going men. This would furnish the necessary rational grounds.

Expectation is in its beginning non-rational. We are often unable to give reasons why certain expectations arise and take strong hold upon us; and more than this, if some one points out the irrationality of a certain anticipation, we are not always able to give it up at once.

What is termed unconscious inference is usually mere expectation of the reproductive type. Inference requires that the two factors shall be held apart and known as two, the one as condition and the other as result. Now in unconscious inference there is no recognition of the ground as such. Perception is an illustration of the confusion of expectation and inference. Here the impression and attendant idea at once assimilate, so that the conditions of inference are not present; the supplementary process is one of reproductive expectation. This point will be more fully considered in another section.

When the expectation is a voluntary construction, we call it a plan. This must be built on rational grounds or disappointment will follow. A plan is at first the work of simple imagination. Expectation may not be active in it because we are not able to introduce into the series conditions which will rationally con nect the end with the present situation. As these are gradually brought into the train of ideas, expectation naturally follows.

The term infer is not used by itself in reference to plans of a personal nature. You do not say 'I infer that I am going to England this summer,' but 'I expect to go.'[1] When we infer we look at the conditions as external to ourselves, while in expectation our present activity constitutes the first condition, and some movement, some activity of our own, enters into every conditional term of the series. Since all plans in order to reach certain fulfillment must rest on rational grounds, the accompanying expectation must be inferential. This is possible because expectation can adopt the universal conditions and express them in personal form.

The highest form of constructive expectation is that in which the final image is a construction. It would be impossible for the mind to expect a wholly novel event; it is requisite that the idea at the end of a series have familiar points in it, that it have certain elements or qualities which have been experienced. Aside from this it is only essential that it should have, through a series of ideas serving as conditions, a perfectly rational connection with the present circumstances. Such are the expectations with which we look forward to certain events common not to our individual experience, but to that of a class or country, or the race. Every boy in the United States expects to vote when he is twenty-one years old; most boys and girls expect to marry; we all expect to die. We construct these expectations from observation and from analogy to certain well-known experiences. It is thus that going to sleep, changes from light to darkness, reverses in fortune, sudden blighting of hopes, mediate for us the idea of death. The inference, resting on the observation that other beings like ourselves are constantly experiencing death, easily passes over into personal expectation. There is, of course, the difference well brought out by Dr. Ward[2] between a man's knowing that he must die and really expecting death. The former is the objective, abstract statement of the fact, while the latter expresses it in the concrete personal form and implies, as said above, that the idea is connected through a series of images with the present situation of the individual. Therefore, in

[1] For the psychological difference between *expect* and *intend* see p. 58.
[2] Encyc. Brit., 9th ed., Art. Psychology, p. 63.

most cases, it is doubtless more correct to say that we know, rather than that we expect such an occurrence. The difficulty in constructing such an expectation is the vagueness of the intermediate terms which, in any anticipation, are what give it life and reality. Constructive expectation is involved in every plan for future action which is more than mere repetition of the past. A plan is a recombination of habitual forms of action. A trip to some foreign country never visited before is planned and anticipated as a new experience. But if closely analyzed each part of the train of images will be found to contain something familiar.

So, too, art and invention imply expectation. The work of the inventor must become as definite and real to him as if he had already known and experienced it in the external world. The conceptions and visions of poet and painter can not become a sensuous reality without expectation. The ideas must have a vital connection, through the train of conditioning images, with the present mental situation. Success in any undertaking depends largely on the clearness of the expectation series.

Thus expectation ranges from a simple, mechanical process as immediate as perception — through mediate forms which are at first reproductive, depending on the mechanism of association, then apperceptive and productive — up to the highest forms of construction, the hypotheses of science and all ideals which are realized in art and conduct.

Function.—The function of expectation is to pre-present objects and events so that the mind may be prepared to meet and use for its own ends the varied experiences of life. Although this part of the subject has been referred to frequently in the previous pages, it is necessary to give it a separate, although brief treatment at this point.

Expectation is an example of the principle of mental economy. It takes the materials conserved to consciousness in the association of ideas and makes them serve a wider purpose. It rests upon the mechanism of habit; but not habit understood as the forging of a chain of isolated occurrences, but as the repetition of steps leading to some end. Expectation is the ideal persistence of an interrupted or delayed process, and it points to the

fact that the organism is self-adjusting. If the external stimulus necessary to complete a former sensational experience be lacking or delayed, the mind will furnish sufficient to produce the corresponding image, and expectation will take place. Thus it always signifies an incomplete activity. No image is an end in itself, and the expectation image points to the delayed sensation.

These two characteristics, its incompleteness and its symbolic nature, afford the basis of its serviceableness for conscious life. By means of them the mind is prepared for coming events. Consciousness in this way is enabled to do much more with the experience when it comes. Such conditions open the way for control in consciousness. The organism is no longer at the mercy of present stimuli which take it by storm, as it were, it is prepared for them; and, being freed from the tyranny of immediate gratification, the mind learns how to regard prospective good, and to reshape and determine its own activity.

In addition to the practical work of preparation, anticipation has a distinctly cognitive function: that of assuring the mind of the real existence of objects not present to sense-perception. This point will come up for further consideration later.

Expectation is the basis of all teleological processes. It presents an end towards which the mind presses through all intervening obstacles. It makes no difference how distant in time and space the end may be, so long as it is vitally connected through the chain of images with the present experience, thus forming a part of a yet-to-be-completed activity, an activity which will be completed only in the realization or disappointment of the prospective state. That the most confident expectations may end in disappointment is not to be disputed. This is due to the fact that the mind has failed to use the proper means toward the end; that somewhere in the series there are images which are not rationally connected with their associates. The person of sanguine temperament often constructs his expections upon an unsound basis, and thus is doomed to disappointment.

VII.

Relation of Expectation to Other Mental Processes.

Relation to Conception.—The intimate connection of expectation with memory and imagination has been considered; its relation to other processes must not be overlooked if we would understand its true position and importance in conscious life.

The working of expectation under the principle of economy suggests a possible kinship to conception which is an overt expression of this same principle. The preparation of consciousness for coming events, which is rendered possible by the mechanism of habit and the prevision of expectation, is greatly furthered by the process of conception. The mind which has a large and well-arranged system of concepts is the one which is best prepared for a varied experience. New objects are readily classified; new lines of action are quickly decided upon because some waiting concept is at hand to appropriate the incoming stimuli. Kant's familiar saying that 'concepts without percepts are empty, and percepts without concepts are blind' comes to mind. As a matter of concrete experience the two are never separated. It is only by a process of abstraction that one gets an absolutely empty concept or a blind percept. But theoretically empty concepts are always waiting for their filling. In this respect they are like expectation which always looks toward a sensuous fulfillment.

Again, the concept resembles expectation in being a readiness to react to stimuli of a definite kind; but this 'kind' is much wider in range than in the case of anticipation. The concept, unlike expectation, involves both past and future reference. The actual form of reaction, the knowing in what particular way to react, constitutes the retrospective element; the readiness to react, that 'restless, forward impulse,' constitutes the prospective element. The latter seems to be the more

primitive of the two. If the concept be traced back to its starting point, it will be found indistinguishable from expectation. The first experience of the child furnishes a form for the second, and after this he is ready to react to repeated stimuli; but there is only one way in which he knows how to respond. This one reaction, then, must be given to a number of different stimuli, so that it functions as a concept.[1]

On the other hand, this same first experience leaves its image in the mind, and this image naturally suggests the repetition of the activity, that is, it anticipates it, according to the method described in the section on the genesis of expectation. Now the image in the last case is identical with the 'reaction,' or the conceptual form, in the former case.

This reaction is of course too concrete for what is meant by a concept proper; but it is that out of which the concept rises. The method of development would be somewhat as follows: Antecedent to the formation of the first class concepts there must have been many expectations which failed of exact fulfillment, but whose main points were common with those of the actual occurrence. As a result of only partial fulfillment, such ideas in standing for future experiences would not be at all rigid in their outlines, so that slightly differing complexes of sensation would appear to satisfy the demands of expectation equally well. The definiteness of expectation would be gradually lost and the idea in its forward reference would become generic. Such a process as this would be historically contemporaneous with the development of the generic images through memory; the two processes supplement each other. At last the content, whether anticipatory or recollective, is wholly disregarded; the conscious state simply functions as the symbol of various concrete states.

We have seen that certain characteristics of expectation are always found in conception, while certain differences are just as marked. It has been said more than once that expectation does not regard the present state of consciousness for what it is immediately worth, but for what it points to. This appears to be

[1] This is essentially Professor Baldwin's analysis of the origin of the 'concept of the first degree'—given in 'Mental Development,' p. 326.

also the office of the concept. Both are thus concerned in the work of preparation, but in a different way; expectation refers to a particular event, more or less definite in outline, while the concept has a more general reference. The content never thrusts itself upon the attention in conception, since all the particulars which tend to rise are inhibited. In thus rejecting them all, the mental state stands for no one individual thing, but for many similar things; it has become a general idea. The temporal difference must again be mentioned. Expectation has but the one time reference, while the concept is universal in this respect also; we may say either that it includes past, present and future, or that it is timeless; which we say depends on the standpoint of consideration. The time relation has been forcibly expressed in the paradoxical statement that the 'concept points to a past not yet completed and to a future already begun.'

The distinctly anticipatory element in every concept may be illustrated by any judgment. In order to affirm that any object belongs to a certain class, I must add to the present percepts others which I anticipate under slightly changed conditions. In the judgment that this object which I see is a book, I anticipate that if I take the book and open it, there will be added to the immediate sensations of sight those of touch and also more complicated visual percepts.[1]

A question may be raised just here: Why is expectation, instead of memory, made the basis of predication? Do we not recall rather than anticipate the supplementary images? Try the experiment in the judgment of the book. If the percepts are remembered, that is, dated in the past, it means past existence for all the qualities except the patch of color given in the visual sensation. The only conclusion in such a case is that one is the victim of an illusion, there is no book before him.

It is not denied that there is also in some circumstances a past reference; but the other is what is essential for all judgment. That the double reference to both past and future is necessary for the idea of permanence can not be disputed, and will be considered further in connection with the influence of expectation on knowledge.

[1] Compare Cornelius, *op. cit.*, p. 93.

Relation to Reasoning. — In the higher processes of thought where an end is sought, as in trains of reasoning, the whole trend of consciousness is forward. The principle of selection is active, trains of ideas are tested and discarded; the whole mental situation demands construction rather than reproduction, so that the highest form of expectation is involved.

At first the final image is not defined. The conditions of the problem, the premises of the argument, these alone are clearly seen. These, together with the relations involved, must indicate the general outline and character of the conclusion. If, when this emerges, it at once appears to be organically connected through this series of conditions with the given starting-point, then the problem is solved.

In purely mathematical and speculative trains of thought the working of expectation is somewhat obscured, but it is nevertheless present, leading the mind step by step, often changing the end according to selective principles until its fitness and perfect coherence with the whole train of ideas announces that the right answer is obtained, and then expectation is fulfilled.

The processes of reasoning and anticipation differ both in the character of the end and of the starting-point. Besides its vagueness, the end in the former case is always an idea, while in the latter it is a sensational content. In both cases the starting-point may be said to be the present situation; but in practical expectation this is always one's self in particular spatial and temporal surroundings, while in reasoning it may be an impersonal factor. The fact that the end term is not a sensational effect and the initial term is not a personal circumstance, eliminates much that characterizes expectation as we understand it. But the method is the same: an end which actually begins in the present situation, and develops more and more through each condition up to its consummation in the final image. This is the process in both instances. In the one case we have personal anticipation and in the other abstract and scientific expectation.

Relation to Attention.—A brief consideration must be given to certain views of expectation which connect it very intimately with attention. It is sometimes called anticipatory, sometimes

preparatory attention. Professor Titchener says of it, "Expectation is simply anticipatory attention to the idea of something which is to happen in the future."[1] Points of similarity may be easily pointed out. Both are distinctly active forms of consciousness; an analysis of physiological conditions shows a predominance of motor phenomena. Both have the same qualitative direction, namely, from an excess of motor activity to that of the sensory kind; both are teleological, and enough has been said of expectation in this respect. That attention is an activity directed toward an end is evident from its selective and inhibitive power and from the accompanying sense of effort. This end is well described by Mr. Stout as 'a fuller and more determinative cognition of its object.'[2]

But points of difference are also conspicuous. The object of attention is within the circle of its own activity; it seeks to emphasize and maintain what it already has. The object of expectation is beyond its present grasp; it seeks to obtain that which it has not. In attention we find consciousness focused on a single element or group of like elements. The whole effect of attention is unifying, coördinating, tending toward an equilibrium; the effect of expectation is to divide the energy of consciousness, and attention is called in to support a distinction which it would of itself tend to destroy. This is particularly true in regard to the time relation; attention opposes, annihilates time distinctions, while they are essential to the existence of expectation. Attention is a general state or attitude of consciousness toward objects; expectation is a process carrying on the interaction of ideas which will not unite. As a general state of consciousness, attention is applicable to any and all particular processes. In so far as any idea becomes clear and distinct, it has come into the field of attention. It is no more legitimate to speak of expectation as attention to an idea having reference to a future event than to speak of perception as attention to an idea having reference to a present event.

It is readily admitted that expectation is more closely allied to attention than is memory in respect to activity; but so are

[1] 'Primer of Psychology,' p. 153.
[2] 'Analytic Psychology,' I., p. 248.

imagination and thinking. The reacting, motor element is evident in the latter, so that all three are to be classed as apperceptive processes; they afford not only active, but reactive experiences. But all are processes which may at any time be brought into the state of attention.

Now 'attention to the idea of something that is going to happen in the future,' implies that this 'idea' is already in consciousness and attention can be fixed upon it. So it is plain that expectation can not be defined in terms of attention, since it must already characterize the content to be attended to. Attention to an idea not already having the quality of 'futureness' may or may not arouse expectation. It often does do this and sometimes causes an illusion. On the other hand, our anticipations of the habitual kind appear and fulfill their function without, as we say, attracting attention.

Expectation defined as 'preparatory attention' is open to objection only because it seems to ignore the distinction between mere consciousness and attention. Expectation undoubtedly is a preparatory state of consciousness; but it is this whether marked by a minimum or a maximum of attention.

One more expression calls for mention. What is meant by expectant attention? When one is directed in the laboratory to give the closest attention to the signal which he will soon see or hear, his attitude of mind is termed expectant attention. This can only mean close and concentrated attention to an expectation. Attention is the same whether directed to past, present or future ideas. It can only make objects clear and distinct whatever their time reference.

So while expectation is often marked by attention, it is just as distinct from it as are other concrete mental processes.

Relation to Desire.—Not all future reference is expectation. This results only when there is a combination of such reference with personal and reality feelings. The importance of the personal element has been emphasized and the necessity of the reality feeling is shown by the contrast with desire. In desire it is essential only that a pleasing object or idea should excite a longing for its possession. The realization of the desire may appear impossible to the subject, whereas in expectation,

attainment, if not immediate, is regarded only as a delayed certainty.

Desire is the conflict or tension between a pleasant image and a less pleasant sensation. This strongly contrasted affective element is lacking in expectation. Here the two factors, presentative and representative, are distinctly recognized; but they may have either a different or the same affective tone, and this may be either agreeable or disagreeable. On the other hand, the realness of the idea which is prominent in expectation is lacking in desire, and the tension so essential to the latter is not necessary to anticipation. If the tension be removed, if it be shown that the attainment of the object would not add one whit to the pleasure afforded by the present condition, desire ceases to be, while expectation, if present before, would still remain. As Mr. Marshall says:[1] "We may desire what we expect and what we do not expect, and we may expect what we desire and what we do not desire." Expectation 'is distinctly differentiated from desire.' It is an 'idea which has the qualities of futureness and realness.'

Relation to Will.—The mechanism of expectation is involved in volition. This statement does not necessarily support those theories which make it virtually the essence of will, as do the doctrines of Münsterberg, Külpe and others. The expectation-idea is the image of some sensational effect; it is the first stage of an activity which may be continued to completion or inhibited by other ideas. The latter possibility is the opening for volition. A single end appearing as the sole terminus of a series of ideas may form an expectation, but can not constitute a volition; the foresight of several ends and the conditions leading to them, the selection of one and the inhibition of others—all this is essential to volition.

Again, in will the means toward the end are supplied from within; in expectation their source is external. Volition implies a foreseen end plus a subjectively initiated activity which is the condition of the result. If the end be obtained without consciousness of such activity, there has been no volition, though of course there was expectation. Take a simple illustration:

[1] 'Pleasure, Pain and Æsthetics,' pp. 276, 279.

If a friend has promised to meet me at a certain time and place, I expect him, I do not will that he shall be there. Any consciousness of motor activity which I may have is not regarded by me as a means of bringing about his appearance. Expectation always implies the idea of some external stimulus. If, now, we consider the factors involved in the representation of my being present at the appointed time and place, we see that this comprises something more than the expectation. Here, in addition to the train of images ending in the one of being present on the spot, there is also the idea of means selected to bring about the result and the inhibition of ideas that would hinder it.

Bosanquet, in his 'Psychology of the Moral Self',[1] says that we find the same two elements in will and expectation, but they are differently connected. 'In expectation there is some connection other than the anticipatory idea which we know to be the operative link in bringing about the result'; and this is the consciousness of 'an external cause.' In cases of volition the anticipatory idea is enough, provided we think of this 'as connected with the result.' But the truth is that in order to think of this 'as connected with the result,' we must introduce another idea, namely, that of ourselves as means to the end. Take Bosanquet's illustration and carry it a little further. We are expecting to hear a bell ring. According to him, as soon as we hear the sound it is referred to an external cause, implying that expectation includes the idea of such a cause. But suppose that besides expecting to hear the bell ring, we know that its ringing depends entirely upon ourselves. Now in the will to bring about this result, there must be something besides this anticipatory idea of the sound. There is only one way in which we can think of this idea 'as connected with the result' so as to have volition take place, and that is by adding the idea of our own motor activity as direct means to the end. It may be readily admitted with Bosanquet that in the case of expectation the added stimulus which changes idea into sensation is due to an external cause. Must it not be admitted then, in strict consistency, that in the case of volition the added stimulus is due to an internal cause?

[1] Page 73.

It is not in place here to discuss the nature of this 'cause' either external or internal, and for psychological treatment the word stimulus is preferable. The fact to be insisted on here is that in expectation the result is ascribed to a stimulus or cause which seems to come from without, and in volition, to one that seems to come from within consciousness.

It has been said that the expectation image initiates a complex activity. It is plain that volition implies several such lines of activity, and the ultimate dominance of one of them after conflict. It is not enough, however, to have a conviction that this one line is to be followed; that, as we have seen, would identify the process with expectation. The difference already established must be insisted upon. Volition is the selection of one line of action out of two or more such lines, plus the conviction that a subjectively initiated activity is the essential condition for the end. In view of this distinction it may be asked whether it is possible to regard the same event from the two standpoints. Take the illustration already used. If the ringing of the bell depends on one's own will, can he also expect that it will ring? Yes, but his expectation rises after he has determined to do the act. The determination ends the volition, and the act is given over to the physiological mechanism. Now the conditions are right for expectation, the stimulus which is to give the *sensation* must come from without. A study of the illustration as first stated shows that the object of the two processes is not quite the same. We will the *actions* that are the means of bringing about the sensational effect which is the real object of expectation. It is the ringing of the bell which we will and not the hearing of the sound, which is what we expect. One's attention, in anticipation, is fixed principally on the sensory part of the content, while in volition it centers about the motor concomitants. The two processes are not identical nor contemporaneous; but, where will is involved, successive; every complete act of volition terminates in expectation.

So long as a line of action is open to volition, one says, I *intend* to do so and so. When the deed of will is performed and all alternatives are excluded, then he can say, I *expect* this will be done. But not to expect an event after we suppose that

we have willed it, is sure evidence that the volition is not completed; alternatives are still present.

Relation to Belief.—That expectation is a form of belief no one can doubt, but the two expressions are not equivalent even in reference to the future. We may believe that which we can not be said to expect, as, for instance, events predicted by science which are to take place outside the range of one's own sensory experience. We may believe, but, strictly speaking, we do not expect that an eclipse of the sun will take place in South America on a given date. In like manner we believe that the sun will rise one hundred years from now. So, too, we believe that it will rise to-morrow, and this we may also expect, but merely to expect it will be to limit the fact to our personal experience; whereas we certainly believe that it will rise whether we are alive to experience the fact or not.[1]

Expectation is a personal term, belief an impersonal one; expectation refers to events of one's individual future experience, belief to events of general future experience. We may expect certain occurrences to happen to ourselves; but that the like will happen to others must be a matter for belief rather than expectation. It is, however, always correct to speak of one's own expectations in terms of belief, but in so doing we remove them from the merely individual sphere and give them a larger setting.

In anticipation, it must be remembered, the end is a sensational effect, and this appears as the last term of a series in which our own present state is the first term. In belief our own state does not necessarily enter in as a condition, nor does the end present itself as a sensational effect. Belief regards the end in its relation to other facts of the external world and not in relation to one's own sensory experience. It carries the same conviction in regard to the occurrence, but this is abstracted from the personal setting, and the latter may or may not accompany belief. It supplements expectation, having doubtless arisen as an extension of the principle to impersonal concerns. Neither of the two forms is necessarily rational. Many people are un-

[1] Sully gives the name 'quasi-expectation' to this form of belief ('Illusions,' pp. 307–308).

able to give logical grounds for either their beliefs or their expectations.

Relation to Emotion.—Is expectation an emotion? It is usually assigned to this class of mental processes. But does such a classification recognize the important intellective work which it performs? It certainly differs from all other emotions in the fundamental place which it occupies on the cognitive side of consciousness. The writers who have emphasized this latter aspect are generally those who do not give the process any specific classification, but treat of it in connection with ideation. Its claim to a place among emotions is based on the presence of organic sensations or 'bodily resonance.' This is a factor not to be ignored, still it has doubtless been exaggerated. Most habitual expectations are aroused, perform their function and pass away without any appreciable 'bodily resonance.' Nor is the intrinsic nature of expectation at all disturbed by the absence of this characteristic so essential to emotion. The absence of definite affective tone differentiates anticipation still further from emotion. We have seen what the variations may be in affective coloring, pleasant or unpleasant or indifferent. In this respect the process is like perception and memory. Just as memory forms the intellective element in retrospective emotions such as grief, remorse and revenge, so expectation forms the intellective element in the prospective emotions of hope, fear, dread and others. All these feelings have a marked affective tone and also invariable relations to desire and aversion. If the affective element is abstracted, say, the unpleasantness and aversion from dread, or the pleasantness from hope, the emotion is destroyed. We have already found that such is not the case with expectation. Pleasure may give place to pain, pain may wear off into indifference, desire may fade away or aversion be suddenly removed, but the expectation with which each is connected remains expectation.

What is called strained expectation can be distinguished from strong emotion; it is the intense mental activity accompanying attention to an expected idea. It may be attended by various emotions, fear, dread, courage, joy; or, as in experiments in the laboratory, it may be intense, but affectively colorless.

Perhaps the fact that the expectations which have an interest for us are accompanied by emotion, has tended to a confusion of the two states; while the multitude of commonplace anticipations that serve their purpose of preparation in the routine of daily life passes unnoticed. The prevalence of organic sensations in both expectation and emotion is a bond of connection between them, and in this respect we have seen that expectation differs from memory. But these same sensations are prominent in other phenomena, such as desire, attention and volition, and their presence here is not considered sufficient to bring these various processes under one class, but only to indicate nearness of relation; and expectation undoubtedly shows a kinship to all these forms. Still there remain certain characteristics which suggest a closer relation to intellectual than to emotional or conative processes. Notice the following points of difference between the cognitive and emotive factors. An intellective element refers to that part of an experience which is objective, pointing to something independent of the self; the emotional element carries with it only a sense of the subjective worth of an experience. Intellection gives information of what is outside the individual mind; feeling gives information about the way in which the mind is affected towards an object. Memory and expectation are in this sense objective; they may be accompanied by agreeable or disagreeable feelings, but their end is to present the object in certain time and space relations to the subject. To see an object, to remember seeing it and to expect to see it, all contribute to knowledge about it, and are all alike intellective operations of the mind.

Expectation is like memory in its origin, having its rise in the mechanism of association. It is also correlative with memory in the development of the idea of time and of personal identity. It is closely related to imagination in its constructive power, and it resembles both memory and perception in its objective reference, since it gives its objects definite time and space relations in the orderly system of the external world.

To rank an ideal content which has a past reference among intellective phenomena, and then to place a similar ideal content having reference to future time among the emotional elements, is inconsistent.

In emphasizing the intellective qualities, we are not ignoring the emotional coloring nor, indeed, the conative tendencies of expectation. All ideas, it must be remembered, are motor. The external stimulus is received into and worked over by a never ceasing, centrally initiated activity which ever tends to express itself in outward acts. All consciousness is conative. Some processes, even on the intellectual side, are more active than others; conception and memory are more passive than perception and imagination. The term usually applied to the more active forms of the intellective consciousness is apperception; but apperception implies attention, and attention is a conative form. So we find that there is no hard and fast line between the so-called divisions of consciousness. On the side of feeling, too, we have a gradual transition in passing from the affectively toned sensation to pure emotion.

The chief work of intellection is to receive and work up materials for the practical use of the organism. On one side stands memory, the most passive form; on the other, constructive expectation with all its motor and affective characteristics. When we consider the nature and function of expectation, we realize that it serves as a connecting link between the intellective, conative and emotional aspects of consciousness. It is thought rehearsing for action, and responding to its affective tone. But it is always thought and must be classified according to its predominant characteristic. So we place it among intellective processes.

VIII.

Expectation and Knowledge.

That expectation plays an important part in our knowledge of the world is unquestioned. All events for which we are consciously or unconsciously prepared have a different significance for us from those which are thrust blankly upon us. Our concrete knowledge of objects is somehow dependent upon our expectations. This leads to the further inquiry whether expectation enters into the categories of thought which underlie all knowledge.

Before taking up the more objective side of knowledge, a glance must be given to the subjective necessity of future reference in order to explain present consciousness. The existence of a past reality is readily admitted; but such existence is, from the psychological standpoint, wholly ideal. This reality is believed in because it is absolutely demanded to explain the meaning of the immediate contents of consciousness. But the presupposition of a past affords but partial explanation of the present. There is much that would remain wholly enigmatical without the presupposition of a future. We are forced to the admission that so-called future experience, which is symbolized in the present state of consciousness by certain well recognized ideas, is just as vital to the construction of knowledge as a memory experience. A threefold time reference is essential for any complete judgment of cognition.

In order to affirm that we know a thing, we must be aware not only of its present behavior, but of what it has done in the past and what it is likely to do in the future. In so far as we do not know its potentiality, we are ignorant of its nature. Scientific knowledge is required not only to give account of past history, but to predict the future career of the object. It regards the object not merely as effect which has a cause, but as itself a condition for yet unrealized results. It views the present state

of a thing as a dependent term midway in a series, part of which is accomplished and part yet to come and we understand its nature in so far as we know the whole series.

Coming now to concrete cases, let us see how expectation affects knowledge of reality.

The concept of reality originates in primitive perceptua experience. Primarily, that which opposes is real. The process by which an object is first apprehended and given a value for experience is perception. Bare apprehension of reality, however, does not constitute perception; for the latter contains representative as well as presentative factors and is an apperceiving as well as an apprehending process. Any illustration will show the two factors. In perceiving the building across the street only the visual and musculo-optical sensations afford immediate data. The impenetrability, roughness of surface, size, distance, are all derived from representative factors which are aroused by the sensations and must assimilate with them to form the perception of a building.

But in what relation to the presentation do these suggested ideas appear? Surely, although there is no conscious anticipation, the implicit reference is futureward. In the normal state of mind the world of objects is looked upon in a practical light as a stage for action, and our immediate apprehension of objects is supplemented by ideas which suggest further experience. There is no immediate demand for the realization of this larger experience, and it remains in the ideal form, standing for what will be when certain conditions are carried out. This enables one to form plans for action in reference to any object as a whole, without waiting to verify by actual experience various ideational factors involved in complete perception.

Mr. Stout's analysis of this process is so excellent that the implication is seen at once. His contention against Professor Bain, that a representation is not a literal reproduction of some previously experienced particular, supports the present claim that the representative idea has a direct future reference. He takes for illustration the relation between the visual sensation of a lump of sugar and the idea of its sweetness.

"What is suggested," he writes, "is not past particular ex-

perience of sweetness, but the idea of a new particular sweetness connected with the present bit of sugar. *This* sugar suggests *this* sweetness. * * * If the sugar seen is beyond my reach, then the sweetness suggested is beyond my reach, although in all my past experience the sugar may have been easily attainable. If it be a bigger piece of sugar than I have before had experience of, I anticipate a more extended enjoyment of sweetness."[1]

What could more clearly show the implication of expectation in perception? The non-present quality is prospective, is what will be — or at least what could be — enjoyed upon the fulfillment of certain conditions. Since these conditions are one's own movements, and the ideas standing for the latter form a series which has its end in the sensational effect suggested by the actual presentation, we have here the whole process of expectation implied in perception. It will be seen at once that in any judgment of perception it is the side of the predicate, and hence the concept, that bears the stamp of expectancy. To perceive reality means to have sensations along one or more sensory lines accompanied by anticipatory ideas of sensational effects which would be aroused under slightly different circumstances. If at any time we wish to prove that an object is a reality, how do we do it? By fulfilling these expectations, implicit in perception. If the images were retrospective, we should be helpless in regard to proof.

Illusions. — No better proof that the supplementary ideas of perception are anticipatory could be asked for than is afforded by illusions. Take up the statement of the last paragraph. According to this, reality is proved by fulfilling the anticipations; but an illusion rests on the impossibility of fulfilling them. The fact that hallucinations and many forms of illusion follow upon expectation, does not bring any discredit upon the latter process, since it bears the same relation to perception that it does to illusion. Sometimes illusion is called false perception. The underlying psychological process is the same in the two cases, the difference lying in the correspondence and non-correspondence of an external object with the idea.

[1] 'Analytic Psychol.', Vol. II., p. 45.

An illusion is a misinterpretation of facts. In the field of perception it is an incorrect judgment of ideas in their relation to the sensory experience. Immediate apprehension is always correct, and so, since ideas are the material for interpretation, illusion creeps in at the point of connection between sensation and ideas. For example, in looking around me in the uncertain twilight, there is no doubt that the patches of color which I see just beyond me are real. But this is of little moment to me; I am interested to know whether the *thing* which I perceive, the *man* standing over there, is real. Is there anything more than the visual percept? Is the appearance tangible? Will it accomplish certain actions which I ascribe to it? Will all my spontaneous expectations in regard to it be confirmed by further examination? I advance and touch the object and find it is only my cloak and hat in some unusual position. The illusion lay in the judgment *about* the reality, in the misconnection of the suggested ideas with the sensory impression. According to the previous analysis of perception, these judgments regarding absent sensations which are suggested by the present impression, have the future reference; they are implicit judgments of expectation. In perceiving the man, I *expect* to see the shape move towards me, to stretch out its hand; I *expect* to feel its grasp upon my arm. So the illusion lies in these judgments of expectation.

But suppose the object in the above instance turns out to be a real man; it moves, it stretches out a hand, it almost grasps my arm and would do so had not my expectations prepared me and enabled me to elude the movement. In this case the significance of the perception lay in the judgments of expectation. It is plain, then, that anticipation is in no way responsible for illusions; these rest upon ignorance of conditions and must be charged to the classifying and generalizing processes.

Dr. Seashore, in his study of 'Illusions and Hallucinations in Normal Life,' states as one conclusion from many experiments that 'Expectant Attention is one of the sources of hallucination, since it induces sensation in the absence of the normal stimulus.'[1] The laboratory experiments of others emphasize

[1] 'Studies from Yale Psychological Laboratory,' Vol. III, p. 65.

the fact that expectant attention is one of the surest sources of fine discrimination in sense-perception.[1] Both observations are correct and go to prove that expectant attention, or, as we should prefer to say, attentive expectation, has the same relation to true as false perception. It could never of itself give rise to illusion. There is always implied some misdirection of attention, some false connection of ideas, or of ideas with sensory impressions. This being given, the more concentrated the attention the more likely is the illusion to occur. Attentive expectation issues in illusion only when it is started on the wrong track. The only way to avoid illusions from this source is to inhibit them by means of counter expectations. This involves having one's attention well distributed, on the alert for variations in conditions rather than concentrated on one set of conditions. Dr. Seashore suggests this remedy when he says that we suffer illusions 'because we will not take the temporary circumstances into sufficient account.'[2]

This misdirection of attention is the source of illusions of memory as well as of expectation. Certain perfectly probable details are suggested by another person or one's own mind in connection with a recollection, and if the attention fastens upon them, ignoring the real conditions, they blend with the recollection, and an illusion of memory is the result.

Very true is the terse statement that 'Man makes mistakes because he is rational.'[3] If the mind were a mere mechanism there could be no mistakes. It is in the attempt to coördinate his ideas according to some principle, to discriminate, select and adjust his mental data, that man lays himself open to mistakes and illusions. The only method by which they can be avoided is the further exercise of this same rational faculty, and a more cautious adjustment of the data. The process of expectation must not be left to the guidance of chance suggestions and temporary interests, but must rest on rational conditions. A well-disciplined mind knows how to control attention, to distribute without scattering it, and thus to

[1] See 'Külpe's Outlines,' pp. 39, 303.

[2] *Op. cit.*, p. 29.

[3] 'L'Erreur,' par Victor Brochard, p. 200.

keep track of varying conditions and give them their right relations.

Any given illusion may be tested by attempting to fulfill the expectations implied; that is, by appealing from one sense to another; and further, by appealing from individual experience to general or collective experience under like conditions. Expectations may be tested in a similar manner without waiting to see whether they issue in true or false perception. The test is made by noting whether all the present conditions are like those which have at other times preceded the anticipated result. Confidence in judgments of expectation is justified when they conform to those of collective experience, or, ultimately, when they rest on rational grounds. It is only the expectations that persist after being tested that are of the stuff which enters into knowledge. Because some anticipations lead us astray is no reason for distrusting them all. Knowledge in its reference to reality as permanently existent whether present to the senses or not, involves expectation. To refuse credence to its deliverances would be suicidal to science. In so far as the process is generalized and rationalized it becomes trustworthy. One may well be sceptical in regard to his individual anticipations; but he must put confidence in the expectations which he shares with the rest of the world.

Knowledge of Reality as Permanent. — It is but a step from this implication of expectation in perception both true and false to the part which it plays in all knowledge of reality. What do we mean when we affirm that a thing which we do not now perceive really exists? Our belief in its existence persists after the object is lost to perception. We constantly represent it as existing from moment to moment in time, parallel to our own continued existence, but independent of this, and affording a permanent ground for the renewal of our former experience. If the name of any object calls up only past experience, without a suggestion of possible renewal, it means that the object is not now existing. It has been, but with all anticipations regarding it, all future reference shut off, it is not now, an existing reality.

James Mill was the first to emphasize this element of expec-

tation in our belief in permanent existence. We find him saying that when the object is one which we have ourselves seen, but is not now acting upon the senses, both memory and anticipation are concerned in the belief; and further, that 'belief in past existence not memory is belief in testimony and uniformity of the laws of nature. Belief in testimony is a case of anticipation of future from the past, and belief in the uniformity of nature another name for the same thing.'[1]

Expectation and the Categories.—It has been shown that expectation is essential for the development of empirical concepts. What relation has it to those more generalized concepts known as categories? It is widely affirmed that these most general forms underlie all experience. But would not the conditions be satisfactorily met if it were said that the categories are involved in earliest experience along with that which is later called the material of experience? There are good reasons why the material aspect emerges in the shape of percepts and 'things' before the concepts are consciously recognized. Then, when the recognition takes place, we are so strongly impressed with the fact that we have been using the concepts all the time, that we fallaciously infer that they were in existence before sensuous experience began.

Concept and percept are contemporaneous and correlative developments in consciousness. Changing the terms of the expression, it may be said that the forms of knowledge and the contents of knowledge are mutually conditioning and virtually inseparable phases of all consciousness. From the beginning every state of consciousness may be regarded content-wise, giving rise to the concrete processes of perception and imagination, the latter including both memory and expectation; or function-wise, resulting in concepts, abstract ideas and categories. In the beginning there is but the one total fact: the 'big, blooming, buzzing confusion,' in which, as Professor James says, 'all the categories of the understanding are contained.' Percept and concept, content and form, are correlative aspects of consciousness from first to last.

[1] 'Analysis of the Phenomena of the Human Mind,' I, p. 299. Also see Cornelius, *Op. cit.*, pp. 110–111.

If this analysis is correct, we shall expect to find some sort of objective experience correlative with every form of concept; and on the other hand, we shall understand that no perceptual experience can take place without involving the activity of one or more categories. Under these circumstances it is quite correct to say that the categories underlie the experience. In any particular judgment of perception it is easy to point out the conceptual element which in logical terms is known as the predicate of the judgment. But we have already found that this logical predicate is psychologically resolvable into various factors of expectation.[1] By analysis of the concept also, we have found that it means expectancy toward a certain class of stimuli. Upon these two grounds, then, we should look for the element of expectation in any category which has its root in our actual experience with reality. In a general way this could be expressed by saying that in every immediate experience with reality (perception) there is expectation of further experience (conception).

Turning now to the fundamental category of substance, let us inquire how the matter stands in a specific case.

What, first, is meant by the term substance as applied to a particular thing? What, for instance, is the substance of this paper? It is not to be identified with any one of the attributes. We acknowledge that if all the properties could be abstracted at once, nothing would remain; yet we are certain that substance is not the mere sum of its qualities. But what, it may be asked at this point, is meant by quality? What is meant by color, the whiteness of the paper, for instance? It can only mean the capacity to reflect light in a particular way and arouse a certain sensation in consciousness. Even the essential quality of the writing-paper, its capacity for receiving symbols, only means that under certain conditions, one of which is contact with another substance, the pen-substance, the expected signs will appear. These capacities or qualities are what we *expect* will take place under certain circumstances. Negatively, then, we assert that substance does not mean the sum of distinct qualities which *have been* manifested to us. It implies the contin-

[1] See p. 50.

uous or continuing *exercise* of capacity. If the effect upon consciousness ceases, we say the substance has ceased to exist or has been removed.

So the concept of substantiality does not permit us to think of the paper as the sum of attributes which can be retrospectively viewed, one by one, but rather as a unity always functioning in definite ways. The paper really *is* and *is only* that which it is now *continuing to do*. This idea of stability in the manifestation of activity is not to be divorced from substantiality. The old semi-popular, semi-scholastic idea of substance as an unchanging, rigid core of reality, is not acceptable to the philosophy of to-day. It was, in fact, only a sort of hypostatizing of the functioning process of consciousness. No better expression of the essential meaning of substance can be given than is found in the following passage from Lotze: "It is utterly inconceivable that we should ask for the 'what' of anything and yet look for the answer in anything except that which this thing is and does; that we should inquire as to its '*being*' and yet seek this anywhere except in its activity."[1]

It is as a center of activity that the idea of substance has validity in the world of reality. This activity is of a definite and orderly kind, one that can be depended upon; an activity which gives assurance of power to repeat its original effects upon the mind. There must be, on the part of consciousness, not only immediate apprehension of opposing activity, but the persuasion that this will so continue that it may enter again and again into conscious experience. Mill's familiar phrase, 'the permanent possibility of sensation,' although by no means an exhaustive definition of reality, well expresses the prospective element in the category of substance.

The concept of substantiality becomes a force *in* consciousness long before it is an idea *for* consciousness. It is only after repeated experience that the idea of persisting activity with its forward and backward reference comes to be added to the immediate apprehension of various qualities.

Professor James, in his essay on 'The Sentiment of Rationality,'[2] emphasizes this prospective factor, regarding the desire

[1] 'Metaphysic,' Transl., ¶ 145.
[2] 'The Will to Believe,' p. 79, ff.

to have the spirit of expectancy defined and the belief that our rational expectations will not be disappointed as the basis of the philosophical doctrine of substance.

The principle of sufficient reason expresses the belief in the rationality of the universe, and this belief asserts itself in response to the demand for an ultimate explanation of reality as we meet it in actual experience. "How did this come to pass?" we inquire, and no less, "*Why* did it happen?" The answer to the former question comes to us through natural law and the investigations of science; while the latter can be solved only by the reference to some end, the presupposition of a plan, which includes cause and effect, ground and consequent. These two categories, the one of mechanism and the other of finality, are not separated in concrete experience; they work together, suggesting and supplementing each other. The separation of the two is one of the abstractions brought about by the complexity of experience. Under the strain of attempted explanation this principle of sufficient reason splits into two forms; one part of the 'nature of a thing' is categorized under causal law; but there is still left a large residuum of that 'nature' which can be explained only by direct reference to an end to be accomplished. Structure and function are equally necessary to explain the universe.

The physical sciences under the retrospective influence, and the biological under the prospective, have established their doctrines; and again, natural and normative sciences have given expression to the two tendencies of the principle. History on the one hand and prophecy on the other are further illustrations of the two aspects. History gives an orderly account of the events which have served as conditions for the present circum stances; prophesy or prediction, whether religious or scientific, has its origin in the attempt to explain some present emergency or perplexity which has arisen in the affairs of a nation or individual or in the operations of nature. The present is never wholly rational in the light of the past alone, the future contains the end, the goal which justifies and interprets the mysteries of the present, and so men have ever sought to read the future. A circumstance inexplicable from past data alone may be justi-

fied by supposing it to be the condition of a changed order of events in the future, or of new phenomena in nature. In so far as everything proceeds in its habitual way and to the satisfaction of every one, there arises no demand for a prophet, no incentive to scientific research. These mean a breaking with the past, an acceptance of new possibilities, a reconstruction of experience.

Now the psychological process which makes all this possible is that of expectation. The vision of the ancient seer and the prediction of the modern scientist may be considered as instances of constructive expectation. In the former case the grounds of the conclusion were not explicit in consciousness, and so the content of the vision was thought to come from some divinity. As knowledge has advanced along the lines of social, political and physical science, the grounds of expectation have come into consciousness, and the ancient oracular utterances have given place to the predictions of science.

The concept of teleology is teeming with expectancy. Its psychological origin is in the determination of the present activity of consciousness by a future idea. But the full significance of the principle is realized only when consciousness, in view of conflicting trains of expectation, selects an end and uses the means which are known to lead to its consummation.

Turning now to the mechanical aspect of sufficient reason, the causal category, we inquire whether this principle, which is invoked to explain the bond of connection between known events, fulfills its function without the implication of expectation? We may consider some single instance of cause and effect, which lies wholly in the past; but from the standpoint of the cause as such, this can not be. To know a thing as cause is to know what it may be *expected* to do. Heat as the cause of melting lead does not refer to past instances, but to present conditions which shall determine future cases. Cause abstractly taken can not be comprehended under any merely past reference. The very relation of cause to effect means that the cause has not yet completed its work. It refers to the future, and is always 'expecting' fulfillment in the effect.

The concrete experiences in which the causal category has

its origin are the attempts to readjust an interrupted habit and to explain the break. An undisturbed recurrence of events, an experience in which expectation is always fulfilled, would never give rise to the idea of cause. Disappointed anticipation, interrupted activity, breaches of custom, these are what lead the mind to analyze complex conditions, and discover the orderly and interdependent arrangement of parts within the whole. Association and custom are essential antecedents to the genesis of cause; but discrimination is absolutely necessary in order to analyze complex facts into their elements, and to hold the elements apart.

The supreme category of science is the uniformity of nature. This is the result of the principle of sufficient reason working through rational expectation. The uniformity which is affirmed does not refer to continued repetition of similar instances. This would beget only a strong reproductive expectation which is not adequate to the inductions of science. If it were sufficient, we should feel the same certainty in regard to all occurrences which are repeated an equal number of times. But this is not true, and it is possible to make a valid induction upon a single experience provided we understand the conditions. The uniformity which science affirms is the occurrence of identical *conditions* in *different contexts.*

The category of time has its root in the psychological experience described in a previous section, and it is not necessary to repeat that account. Memory and anticipation are both essential to its inception and development. As a concept its function is to mediate between absolute static unity and an utter heterogeneity of events, thus making possible all that we mean by conscious life.

The Validity of Expectation. — A popular distinction between expectation and knowledge relates doubtless to the degree of certainty involved. To know a thing is to be certain of it, while to expect it seems to imply less certainty. That which a man knows will happen, he must also expect; but he is not willing to affirm that he *knows* every thing of which he is quite ready to say, "I expect it."

If we look at the development of expectation, we shall un-

derstand why this is so. Primitive anticipation was doubtless attended by the highest degree of certainty. But frequent disappointment weakened this feeling. There were so many breaks just before the final image in the expectation series, that at last, when some suggestion started the train of ideas, upon arriving at this break another end was suggested, and consciousness recognized the possibility of an alternative. So long as two or more trains of ideas divide the attention, definite expectation is inhibited. Through such experiences man comes to distrust at least some of his expectations, and he slowly learns that it is the merely individual anticipations that are thus untrustworthy. To say that one expects a friend, but does not know whether he will come at the appointed time, means that, while the train of ideas which stands for his coming is well defined, other possibilities suggest themselves and succeed in inhibiting definite expectation. To say one knows the friend will come, can only mean that any suggested alternative is at once inhibited. This can take place only when one understands all the conditions involved, and is thus sure that his standpoint and that of his friend is the same. This illustration shows the psychological nature of the common distinction between the certainty of expectation and knowledge. The one is recognized as an individual prevision, and the other as a collective or universal prevision. In the instance given above, the two individuals have the assurance that the conditions are understood alike by both, and hence that their anticipations coincide.

It may be interesting to note further instances in which we make a different use of the two terms.

I am ready to say that I know that the weight in your hand will drop to the ground when you let go of it. I never think of saying, I expect it will fall. If the belief is to be expressed in terms of expectation, it must assume a more personal form. I may say that I expect to see it fall. But does not this imply a possible alternative? I may close my eyes if I choose, or something may attract my attention from your hand. Look a moment at the first case. If, in view of the thought of closing my eyes, I still expect to see the weight fall, it means that, whether consciously or not, I have determined to keep my eyes

open. Now take the other possibility. I admit that something may attract my attention, but I do not anticipate this. That is, after picturing this alternative, my mind immediately reverts to the vision of the falling weight as the actual outcome of my present train of ideas. Expectation becomes definite knowledge only when other ideas are inhibited. Comparing these personal expectations with what is termed knowledge that the weight will fall, we see that while anticipation must take place in the latter case, it can not be a mere individual prevision; nor is it enough to say that the certainty is secured because the two observers agree in the expectation. It is because the known relation of the weight to the ground is such that the anticipation would necessarily arise in the mind of any observer. More than this; there is a firm belief that a weight would fall if the support gave away, even if there were no one to observe it. Knowledge rests on well-recognized conditions, while simple expectation acts without conscious regard to conditions.

If the conditions in a particular case are not known, the certainty of expectation will depend partly on the invariableness of the sequence, and partly on general knowledge. An ignorant man would be certain, because his limited mental capacity could not construct any possible alternative; while the man of wide mental resources would bring his constructive expectation into play. If none of these constructions succeeded in inhibiting the original expectation, it would stand, and certainty would attend it. The well-trained mind may construct an expectation upon purely rational grounds that will inhibit strong reproductive anticipations. On the other hand, it not infrequently happens that one can not inhibit a train of thought and yet can find no satisfactory conditions for it, nor yet construct any successful competing expectation. Still, confidence in the occurrence of the event is in no wise shaken. This state of mind is commonly termed faith or belief in distinction from knowledge. We say, then, that we expect an event when the train of ideas irresistibly maintains itself, but we *know* that it will occur when we can further state valid reasons why the one line of thought prevails over the other; so that the difference com-

monly ascribed to the certainty of knowledge and expectation depends on the recognition of universal conditions.

If we examine any one of the previous examples of knowledge, we shall find that expectation is by no means ruled out of the process. In every case where we *know*, we also *expect;* so that what we have called the difference between knowledge and expectation seems to be a difference in the character of expectation. As pure expectation does not admit of uncertainty, whether it be reproductive or rational, we must designate that which is so characterized as imperfect expectation, where the process has not been allowed to run its natural course. It is only the reproductive kind which admits of this easy displacement; that which rests on rational grounds maintains the highest certainty. The mere subjective assurance of reproductive expectation can never amount to knowledge, since it rests on purely individual prevision. Knowledge requires in addition the universality of the conditions on which it rests.

It is evident that the ultimate test of all knowledge involves this future reference. "Is it true?" does not mean merely, "Is it consistent with experience up to date?" but also, "Will it also realize anticipations of further experience?" The latter question can be answered only by experiment. This, while it may differ in purpose according as it is scientific or practical, is in both cases the realizing of an expectation by working out its conditions. If the anticipation fails to be realized, the fact or idea or hypothesis is not true, and must be reconstructed. But if experiment is successful, the assumptions of the experimenter may become the profoundest truths of science. The conditions having been proved rational, the anticipation must always be fulfilled. Hence, the ultimate criterion of knowledge is experimentation, and this is the fulfillment of an expectation by the concrete realizing of ideal conditions.

Summary. — In the foregoing pages the attempt has been made to show the nature and importance of the process of expectation. It is more or less active from the beginning to the end of conscious life, manifesting itself in the simplest psychoses of the child mind and in the most complex forms of mature mental life. It is equally important with recognitive memory in the

construction of experience. The earliest images are doubtless anticipatory rather than recollective, and are of themselves sufficient to secure for the organism the preservation of life. But all rational and voluntary action involves both the retrospective and prospective elements. Like all representation these images are symbolic, and have their value in their reference to impending sensations. The work of anticipation is accomplished by a complex of sensory and motor images and organic sensations having a peculiar relation to the presentative element in consciousness due to the vibrations of attention, and it is this relation which becomes the basis of the future time reference. The process has no affective tone, but the content may be either pleasant or unpleasant.

Expectations may be classed as immediate and mediate, the latter easily dividing into reproductive and constructive. Plans for future action, the formation and maintaining of ideals, and the inductions of science are of the latter class.

The process is re-active and hence apperceptive. In this respect it shows many characteristics of attention, conation and volition; but it is not to be classed with them nor yet with emotion. It is rather to be placed among intellective processes, because its reference is distinctly objective, while emotion pertains to the subjective side of an experience. Like memory it is representative in form, standing for an object in definite time and space relations. Further than this, its function is to give control over future experience, so that the mind can meet and use for its own ends the varied events of life.

Knowledge of the world about us is dependent on expectation. The supplementary images in perception are anticipatory; illusion is but the impossibility of realizing such images. Belief in a world not present to sense perception also involves a future reference. If the mention of the object calls up only past experiences without suggesting the possibility of further relations with it, it is thought of as no longer existing.

A prospective reference is implicated in many of the categories. Substance, causality, the uniformity of nature and others involve anticipation.

The trustworthiness of knowledge on which science builds

in nowise excludes expectation. In so far as they rest upon knowledge of universal conditions, the anticipations of science are trustworthy and are accepted with such assurance that they become laws of nature. What are the laws of motion, for example, but the expectations of reason concerning the position of bodies in space? We are thus justified, not only in saying that all complete knowledge involves anticipation, but also in affirming that all rational expectation is knowledge.

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Motor, Visual and Applied Rhythms.

An Experimental Study and a Revised Explanation.

BY

JAMES BURT MINER, M.S., LL.B.,

University Fellow in Psychology, Columbia University.

[Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the Faculty of Philosophy, Columbia University, and being Vol. IX., No. 4, of Columbia University Contributions to Philosophy, Psychology and Education. The results of this research were presented before the Section of Anthropology and Psychology of the New York Academy of Sciences, and the monograph is published under the auspices of the Academy.]

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CONTENTS.

PART I. DESCRIPTION AND EXPLANATION OF RHYTHM.

A. FROM THE PSYCHOLOGICAL SIDE.

The attempt to explain any state of consciousness brings with it first the necessity of describing the experience in mental terms. If we can make this explanation elementary enough we shall at once have pointed out the physiological correlate. In so far, then, as we can suggest a physical basis on which this bodily accompaniment may arise, we explain the phenomenon scientifically. In the first part of this paper I shall try to follow through such a course for rhythm. I was led to undertake it by experimentally demonstrating certain muscular accompaniments of rhythms, which I shall describe in connection with the physiological discussion. At the outset it becomes me to recognize the difficulties which lie in the way of any rounded explanation. I am encouraged, however, by the fact that the direction for future progress is often most clearly seen after an attempt to harmonize our knowledge on any poi . into a comprehensive whole.

Primary rhythm has been taken to mean the regular succession of like events, while secondary rhythm brings in the factor of grouping among these events. We shall use rhythm only in the sense of rhythmic grouping. To the psychologist a series of sounds takes on a new interest as soon as they are heard in groups. The grouping to which I refer is a true rhythmic experience, something more than counting the sensations in groups. There is a feeling of the group together. The group is 'felt,' so to speak, rather than counted. Each group is experienced as a sort of whole, which is compared with other wholes. The groups have their limitations and, like other perceptions, they are accompanied by an affective tone. In artistic rhythms the grouping is embellished by ideational associates. In this discussion we are to treat of only the simplest feeling of

rhythm and try to explain that. We seek the fundamental fact that is common to rhythm, whether it be experienced in poetry, music, movement, or in a mere succession of noises. This fundamental fact, which sets rhythm off from other impressions, is that the groups are felt as units. Meumann, who has written the classical German monograph on rhythm, expresses this as the 'Zusammenfassung der Eindrücke.' He says: "The subjective holding together of the impressions in a whole is inseparably bound up with the simplest cases of rhythmic perception."[1] Bolton, in the first empirical study directed specifically toward rhythm, speaks of the sounds running together to form organic groups.[2] He lays much stress on the group appearing as a unit.[3] Squire speaks of the 'unitary character' of the group and of its 'unity for perception.'[4] Titchener calls this the 'essential thing in the perception of rhythm.'[5] We recognize the factor clearly in the case of a series of like sounds at uniform intervals which are rhythmically experienced. Explanations of rhythm have generally been directed toward the unitary character of the group. It is to this factor that I shall especially attend.

As soon as we recognize that rhythm brings into consciousness a group feeling or 'Zusammenfassung,' which is not present in the objective stimuli, we seek at once some conscious process on which this can rest. When the rhythm is experienced from an objectively uniform series, either the sensations themselves must become actually united in time or by real changes in them; or else they must appear united by reason of some other accompanying element in consciousness which adds the group feeling. This element would, as it were, provide the thread on which the sensations from the external stimuli are strung out in groups. I shall contend that the evidence points to this latter suggestion; that feeling the groups to be units is an illusion due to the presence of movement or strain sensations along with the sensations that are grouped; that these sensa-

[1] *Philos. Stud.*, X., 271.

[2] *Amer. J. of Psychol.*, VI., 204.

[3] *Op. cit.*, p. 213.

[4] 'A Genetic Study of Rhythm,' p. 86.

[5] 'Experimental Psychol., Qualitative, Students' Manual,' p. 174.

tions arise from movement or tension started reflexly in the muscles by the external stimuli. These kinæsthetic sensations are interpreted as an apparent change in a uniform objective series. The groups appear to be separated either by a longer interval or by a regularly recurring accent or both. In any case a kinæsthetic sensation within the group gives us the uniting element for consciousness. I shall attempt to develop this view rather completely and point out how other explanations seem to me to be inadequate. In connection with the treatment of the physiological accompaniments of rhythm, I shall present some new empirical evidence supporting this kinæsthetic explanation.

We can most conveniently discuss the questions involved by taking up first three other lines of explanation that have been offered. These ascribe the unitary group feeling (1) to respiration or some other regular organic rhythm; (2) to attention; (3) to expectation and satisfaction.

Suggested Explanations.

1. Regular Organic Rhythms.

Perhaps the most natural factor to select, as providing something in consciousness on which separate sensations from the external world could be strung in groups, would be the sensations coming from one of the organic rhythms. The fact that the rhythmic group repeats itself in a uniform time requires that the element for grouping *may* come regularly. Pulse and respiration at once suggest themselves. The changing feeling due to breathing, for example, would provide a grouping element not found in the external stimuli. It might be completely adequate provided its wave-length corresponded to that of the rhythmic group. Just here, it seems to me, is where any organic rhythm which regularly continues in us at all times fails as an explanation of rhythm. Its period would be practically a constant. A brief consideration of the voluntary conception of rhythm shows that organic rhythms can never adequately explain all rhythmic impressions. The fallacy lies in supposing that any regular organic pulse of movement could be so

changed that its period would agree with whatever length of group was chosen. We can experience a rhythmic group whether the stimuli be .1 sec. or 4 sec. apart.[1] This range is far beyond that of any organic rhythm. Moreover, there are no gaps in the rhythmic experience within these limits, as we would have to expect whenever the rhythmic bodily change did not exactly coincide with the period of the group. By organic rhythms in this discussion I mean, of course, the regular rhythmic processes constantly going on in our bodies whether we are in the presence of serial stimuli from the outside or not.

Squire recognizes that the organic rhythms cannot be regarded as the source of the perception of rhythm.[2] As for respiration, she found that in reading syllables in different rhythms there was only one form, the trochee, and a single case of iambic reading, in which the respiration curve corresponded to a complete group.[3] Meumann criticises the explanation of rhythm by general bodily rhythms. He observes further in this connection that the feeling we get from the constant rhythms is too indefinite to provide a grouping factor. He regards it as inconceivable that 'the uncertain sensation elements coming from the organic rhythms can produce the ordering of the sound impressions in rhythms.'[4] He would doubt, moreover, that the course of these rhythms of the body could be shown to run parallel with the rhythmic impression.[5]

For the most part the suggestion of the feeling from the bodily rhythms has been only tentatively or indirectly mentioned by investigators to explain the binding of separate sensations into groups. The tendency to use this explanation, however, is strong and appears in various forms. It seems to have been emphasized by the work of experimenters like Mentz and Leumann, who have shown that rhythmic impressions are accompanied by changes in the pulse and breathing. Leumann found that, as the rate of scansion increased, the heart beat accelerated and the breathing changed.[6] Mentz comes nearer to

[1] Wundt, 'Human and Animal Psychol.,' Titchener's trans., p. 263.
[2] *Op. cit.*, p. 85.
[3] *Op. cit.*, p. 74.
[4] *Philos. Stud.*, X., 272.
[5] *Op. cit.*, p. 254.
[6] *Philos. Stud.*, V., 618.

offering respiration as an explanation of rhythm. He states that 'a simple metronome beat, as well as the accented beat of a given measure, produced through the direct innervation of the breathing an impulse to the beginning of an inspiration or expiration.' With a subjective rhythm he states that there is also this 'frequent falling together of the accented beat and the respiration summit or valley.'[1] It is to be noted that he speaks of a 'frequent falling together,' and that is what his work shows. However, this occurred when the subject was very likely choosing a rate best adapted to breathing. It would not hold for every period of grouping. Mentz even gives schematic curves showing three and four metronome beats arranged on a respiration wave. Very curiously, under his view, the respiration wave seems to include less beats when the metronome is running at a higher rate.[2] Such investigations are important as showing the effect of rhythms on the bodily conditions. They indicate that a respiration wave may, in some cases, be the basis of grouping; but they leave out of account the difficulties arising if it is attempted to show that the respiration is always the basis of the group feeling. It is far from my intention to claim that rhythms do not affect the organism. This is very different, however, from supposing that the bodily rhythms explain the rhythmic impression.

Organic rhythms are more generally used to explain the preference for groups of a certain period. This seems to be more justifiable. Seashore, for example, in one of his experiments with the free tapping of rhythms, suggests that the length of the group 'seems as a rule' to fall within the range of the respiration and pulse periods of all the subjects tested, or multiples or divisors of these periods.[3] This is without regard to the period of the particular subject beating the rhythm. I shall treat of this question further in connection with the limitations of grouping.

The fallacy of choosing an organic rhythm to give the unitary feeling to a group is the same whether respiration, the

[1] *Philos. Stud.*, XI., 123.
[2] *Op. cit.*, p. 121.
[3] *University of Iowa Studies in Psychol.*, II., 72.

pulse or some other regular rhythm is chosen. Fatigue, for example, is supposed to rise and fall, and might explain the tendency to favor a certain length of group. But a condition of fatigue could not correlate in consciousness with the grouping of a series of stimuli in twos whether they be .1 or 1 sec. apart. A constant brain pulse or rhythm of nervous discharge, if there is any such regular rhythm taking place, would present the same difficulty. We are not justified in supposing that any constant rhythm could be changed and distorted to provide a grouping accompaniment of various periods. Meumann suggests something like a brain pulse in connection with his attention explanation, which I shall treat under that head. MacDougall also allows for such a possible explanation of rhythm, in addition to the factor of kinæsthetic sensations which he mentions. He says: "We may conceive a periodical facilitation and inhibition of nervous activity to arise from the relation between the periodicity of its own rhythm of functioning and certain intervals in the objective series of stimulations. If such a physiological rhythm appears in the functioning of the central nervous system, a periodic increase and decrease should occur in the intensity of the sensations coördinated with a series of unchanging stimulations, according as the elements were coördinated with positive or negative phases of the nervous activity."[1]

He is speaking here, I take it, of a continued rhythm of action which the nervous mechanism may show in some constant way. If there were a regular increase and decrease in the intensity of the current, either from the sense organ or in the brain, we should have a real change in sensations. This would be fundamentally different from the illusion of change on account of kinæsthetic accompaniments, which I suggest. The supposition of such a brain pulse, with the idea that it is comparatively constant, has the same inadequacy as other organic rhythms.

2. Attention.

There is considerable confusion in the use of the word attention by those writers who would ascribe the unitary feeling of the group to it. The wave of attention may mean the fact

[1] *Psychol. Rev.*, IX., 465.

that there is a more or less regular rise and fall in the apparent intensity of a sensation which is continually attended to. We find this in the appearance and disappearance of sensations near the threshold. This wave of attention would probably be explained as correlating with a regular rhythm of the brain or sense organ, perhaps with fatigue and restoration. It would then be open to the objection I have raised to a constant bodily rhythm. Again, attention is apparently used to describe something different from the 'wave of fatigue.' Greater attention is used as a name for the fact that certain sensations in a series appear more distinct to us. This would be a correct use of the term, no doubt, but it would not provide any other factor than the original sensations themselves to produce the grouping effect.

Meumann refers the grouping to straining of the attention. "The general psychological facts," he says, "to which the sensory rhythm field is referred for a basis of explanation, are certain relations of attention, strain periods and the changing extent of the same."[1] Again, he says that the entire phenomenon may be regarded as "an unlike energy division of the attention. * * * When the separate beats follow each other at the rapidity of .3 sec., it is impossible for us to employ the same energy of attention throughout. However, if we alternately heed and do not heed a like number of impressions, we attain the double purpose of being able to follow the progress and the temporal succession correctly, *i. e.*, without losing an impression."[2] With Meumann accent is an expression of the greatest employment of attention. Rhythm may certainly be described as Meumann has here; but we must wonder if, in doing so, we are providing any factor for grouping except the name attention. Meumann surely does not hold that it is the straining of attention which is felt as coördinate with the groups. Attention is not something psychical which we feel. That which Meumann means by attention seems to be brought out somewhat better when we consider his physiological correlate for this condition. He says that the facts of energy distribution of attention are 'to be

[1] *Philos. Stud.*, X., 429.
[2] *Op. cit.*, X., 304.

given a point to hold to in the facts of central energy change in successive perception, of central adaptation and automization.'[1] The central energy change seems very like a brain pulse, although it is apparent that Meumann is struggling away from such a regular rhythm when he refers to 'central adaptation.' This might be supposed not to be a constant process, but one dependent upon the incoming stimuli.

Squire and Bolton also use the attention to explain the group feeling. Squire says: "One group corresponds to one pulse of attention."[2] Bolton's view is that 'only one undivided state of consciousness may arise during each pulse of attention,' and further that 'the number of objects which can be grasped in that state must form an organic unity or be presented as a single object — have the appearance of a unit.'[3] Again, he says:

"This rhythmical grouping was a series of efforts to attend to the sound. The grouping results from a sequence of acts of attention. When the attention is directed to the sensation it lays hold of the first impression with great force and makes it the sole object of consciousness. If this were the only sound, the attention would turn to something else; but as succeeding impressions follow before the first wave of attention has subsided, they are seized upon with less force than the first impression and are subordinated to it in different degrees according to the strength of the apperceptive act. Subsequent waves of attention follow the same process as long as the will directs the attention to the phenomena. The attention accommodates itself to a certain number of impressions, which fall easily within the period of a wave, providing there is no objective difference in the impressions. If there is a regular recurrent difference this becomes the signal for a new act of attention, providing only that the span does not exceed or fall much under the normal period of a wave."[4]

Here we seem to have sometimes a description of rhythm in terms of attention and then again a coördinate for the group in some regular bodily change, which is called here the wave of attention. The quotations from these writers illustrate in what way attention has been used in connection with rhythm. They indicate, it seems to me, that we must look beyond attention if we are to find any real factor in grouping for which we can seek a physiological correlate. It will not do to say that attention does the grouping. Attention does nothing in con-

[1] *Op. cit.*, p. 429.
[2] *Op. cit.*, p. 86.
[3] *Amer. J. of Psychol.*, VI., 213.
[4] *Op. cit.*, p. 211.

sciousness. Neither is it an independent conscious experience which we feel. In describing rhythm in terms of attention we are not providing any element which would bring the feeling of grouping into the series, or else we seem to be providing another regular organic rhythm, which would be as inadequate as respiration to give the rhythmic impression in various voluntary groupings.

3. Expectation and Satisfaction.

Among the German investigators Wundt has set a type for the description of rhythm which is quite generally followed. With him rhythm is an emotion arising out of the regular alternation of states of expectation and satisfaction. 'Der Rhythmus ist ein Affekt, bei dem Erwartung und Befriedigung zusammenfallen.'[1] Smith agrees in general with this description of the experience.[2] It is apparent that we have here a different conscious element on which we may say that the feeling of unity in the group rests. Moreover, this feeling of expectation has not the objection which I have raised to the sensations from a regular organic rhythm. It has no constant period, but changes with the rhythmic impression. Two difficulties, however, are at once presented when choosing expectation to explain the group feeling. In the first place expectation is a rather complex experience and we should seek to describe rhythm in the simplest terms possible. Again, we are at once in a quandary when we seek to correlate expectation with a physiological condition. The primitive feeling of rhythm may mount, as it increases in content, to an emotion of expectation. It seems better, however, to keep our description of the elements of rhythm in terms of sensation, where that is possible. If we reduce this feeling of expectation to sensation terms, I take it that we have essentially the kinæsthetic sensations of tension and relaxation, or of waving movement. This would remove the objection against the complexity of a feeling of expectation and would at once indicate the physiological correlate. Wundt's explanation has the advantage of suggesting an element in consciousness which would coincide with the group, while the feeling from regular bodily rhythms would not.

[1] 'Menschen und Thierseele,' p. 311.

[2] *Philos. Stud.*, XVI., 291 ff.

In connection with Wundt's description we may well consider the emphatic objection of Squire to speaking of rhythm as an emotion. Titchener had raised the question whether rhythm should be classed as a perception or as an emotion, but had not answered it.[1] The argument against describing rhythm as an emotion has two aspects which may be considered independently. As a formal matter we may agree that it is not well to class rhythm as a pure emotion; but in the second place, while doing this, we do not have to follow Squire in describing it as a pure perception devoid of affective tone. If we describe rhythm as we do similar experiences, we may very well say that it is a perception accompanied by a characteristic emotional tone. Squire's objections are well formulated and should be stated at length, for in part they conflict with the thesis which I am offering. She says:

"No explanation which makes the affective elements fundamental to rhythm can be satisfactory. (1) Introspection shows that the rhythmical grouping can occur in a perfectly indifferent conscious state. This was noted by the subjects of Bolton and Smith as well as our own. (2) Feelings become blunted by repetition. If, then, rhythm originates in partial feelings, which Wundt makes intermediaries in each and every group, we should expect a gradual weakening of the affective tone of rhythm with prolongation of rhythm; but this is not true. As a rule the affective tone generally increases for a considerable length of time, especially when organic co-vibrations are set up. (3) The feeling when present does not consist of a series of contrasted feelings, such as any theory which makes feeling the intermediary of grouping must presume; on the contrary it runs a comparatively unbroken course of either gradually increasing pleasantness, or, when reversed, of gradually decreasing pleasantness. The contrast brought out in grouping is ideational in source. (4) No explanation of rhythm which goes out from the feeling side can successfully explain the limitations which all groupings show (the limitations to two and three groupings and their compounds). (5) The gradual growth of rhythmical ability and rhythmical perception can be accounted for only on the grounds of its perceptual nature. (6) The characteristics of the affective curve are not present in the rhythmic curve taken by the pneumograph. The curve, as has been shown, is that characteristic of an attentive state. (7) Furthermore all the phenomena of rhythm can be explained by the facts of perception."[2]

Squire was not the first investigator to object to describing rhythm as expectation. Ebhardt found no feeling of expectation and satisfaction among his subjects, but prefers to speak of a period of strained attention followed by a feeling of empti-

[1] 'Experimental Psychology, Qualitative, Instructor's Manual,' p. 352.

[2] *Op. cit.*, p. 96.

ness.[1] When discarding the factor of expectation on which to base grouping, it is interesting to note that both these writers substitute attention. Introspection, Squire believes, does not show the presence of expectation or of 'alternate feelings of strain and relief.' "What we do find by introspection is a constant forward direction of the attention."[2] If these writers were to state their introspection as to the presence of attention in some non-attention terms, it is difficult to see how they would avoid using kinæsthetic strain sensations. The important feature of this criticism of Squire seems to me to be its bearing on the general psychological method of description. Do we ever have a perception that is perfectly indifferent in feeling tone? What do we mean by indifference? It is commonly assumed that all states of consciousness have some feeling attribute. If rhythm does not we should revise our hypothesis. We should probably agree that whenever the subject is active he is experiencing some change of emotion. It is impossible to conceive an absolutely passive individual. Changes in the body are reflexly started by every incoming stimulus. What then is this feeling of indifference of which we speak? Shall we say that during indifference bodily changes are not affecting us, or is it better to regard them as affecting our conscious content, but not separately perceived. The latter view seems to me in better form. When tension or movement is not specifically felt in rhythm I should regard them as still in the background of consciousness, really affecting the conscious state somewhat as James would say it is affected by its fringe. The difficulty in introspecting the impression of rhythm beyond mere terms of attention easily accounts for subjects not all noting tension or movement sensations. With trained introspectors I have never found any difficulty in tracing what are commonly called strained periods of attention to actual kinæsthetic sensations. Two other points of Squire's should not be passed without a word. What she probably means by the respiration curve not showing affective attributes, is that it did not show the characteristics of expectation as outlined by Lehmann and noted by her on a previous

[1] *Ztsch. f. Psychol.*, XVIII., 191.

[2] *Op. cit.*, p. 86.

page.[1] The claim that emotions always decrease with repetition does not seem to me sound. Melancholy, for example, grows by its repetition until it overpowers us. In conclusion, I would repeat my objection to explaining rhythm by attention when that term may be resolved into kinæsthetic sensations, as I believe it can be here. Furthermore, it seems to me just as much out of the usual order to describe any mental experience started by objective stimulation as a pure perception, as to regard it as a pure emotion. I prefer, therefore, as I have stated, to call rhythm a perception with an affective tone. In doing so I believe we keep closer to the best psychological methods.

4. Kinæsthetic Sensations.

Now that we have considered some of the objections that may be urged to using attention, expectation or sensations from the constant organic rhythms as the factor explaining the group feeling in rhythm, we return to the thesis which I offered previously as adequately explaining the rhythmic experience from a psychological point of view. The thesis is this. The impression of rhythm, or the group feeling in connection with serial stimuli, arises from the coördinate presence in consciousness of a wave of kinæsthetic sensations, due either to a movement or tension of the muscles. The perception of grouping is thus not the direct result of the sensations from the outer world, but is read into the objective series. The 'outer' sensations are not actually grouped, but appear to be grouped. Rhythm thus arises as a time or intensity illusion in much the same way as we speak of space illusions arising from eye movements. This hypothesis is not entirely new to writers on rhythm. Indeed, in view of the almost universal observation of movements accompanying the perception of rhythm, it is strange that it has not been more completely developed before. Almost the first thing that we notice in the presence of a series of sounds recurring at short intervals is this tendency to move. It is felt either as a tension of the muscles or as an actual contraction of them. Before taking up the views of other investigators on kinæsthetic sensations let me repeat with emphasis that the selection of

[1] *Op. cit.*, p. 95.

tension and movement sensations, as providing the conscious factor for the feeling of unity in the rhythmic group, is essentially different from the selection of sensations coming from the diaphragm alone, from any constant organic rhythm, or from a general pulse of bodily feeling. Respiration may at times provide these kinæsthetic sensations for rhythm, but frequently does not do so. It is doubtful if any other regular organic rhythm ever provides the factor for grouping to consciousness. One of the chief characteristics which I would urge in favor of tension and movement sensations is that we are not bound down to any constant rhythm which varies with difficulty and within narrow limits. Movements or tensions in the head, arms, feet, or muscles anywhere may give the conscious element for grouping. They alone do not, of course, explain the limitations of grouping, which I shall take up in connection with the physiology of rhythm. It is in that connection that we have need of constant rhythms to provide a horizon and zenith for our rhythmical impression.

Previous investigators have quite generally referred to the kinæsthetic accompaniments of rhythm. Some of them have approached very near the thesis defended in this paper. Bolton was the first to suggest that 'if the sounds become too rapid to find expression in muscular contractions of any kind, they can be no longer separated from one another as single impressions,' and hence not grouped.[1] Further he says: "The change from one state of consciousness to another is represented by the reversal of a muscular movement. If between two impressions there is not sufficient time or time equal to the reversal of motion in a member, there is not consciousness of an interval between the impressions."[2] Since he regards a rhythmic group as 'one object of consciousness,'[3] we have only to suppose a reversal of muscular activity between the groups to place the correlation of rhythm on a muscular basis. In another place Bolton says: "Each impression as it enters into consciousness tends to find expression in a muscular movement, but the intensive changes in the series of impressions produce corresponding changes in

[1] *Amer. J. of Psychol.*, VI., 220.
[2] *Op. cit.*, p. 221.
[3] *Op. cit.*, p. 155.

the intensity of sensations, which must find expression in different degrees of muscular activity."[1] This traces a rather complete connection between an objectively accented series and the sensations from the muscles. It is incomplete so far as providing a muscular coördinate for grouping from an objectively uniform series. I would contend that the muscular tension or movement in the case of such a series also provides the grouping element. Bolton also makes much of the presence of involuntary movements during rhythmization, to which I shall again refer in connection with my own experiments.

With Wundt we have 'inner tactual sensations' which correspond to kinæsthetic sensations, as the element with which to explain accentuation in subjective rhythms. He says:

> "The primary cause of the actuation of a particular impression is always to be found in the increase in the intensity of the preceding and concomitant feelings and inner tactual sensations of movements. This increase in the intensity of the subjective elements is then carried over to the objective impression, and makes the latter also seem more intense. The strengthening of the subjective elements may be voluntary, when the tension of the muscles which produce inner tactual sensations is voluntarily intensified, thus producing a corresponding intensification in the feeling of expectation. Or the strengthening of the subjective elements may be involuntary, when a grouping of the elements of the temporal idea is brought about as an immediate consequence of the fluctuations in sensation and feeling that take place during the effort to include as many factors as possible in the percept."[2]

Wundt thus recognizes a carrying over of the kinæsthetic sensations to a changed appearance in the objective series, and also the involuntary strengthening of elements in a group by concomitant feelings. 'Strain and relaxation,' which Wundt regards as one of his three fundamental 'dimensions of feeling,' are certainly very clearly connected with the muscles. Rhythm is given by him as the chief illustration of strain and relaxation feelings, although he indicates that rhythm may also show the presence of his other affective dimensions, 'pleasure and pain' and 'rousing and subduing.'[3] There is probably only a verbal difference between Wundt's 'strain' feeling and my muscular 'tension' sensations which accompany rhythm. In connection with accent and with these strain feelings it is

[1] *Amer. J. of Psychol.*, VI., 235.
[2] 'Outlines of Psychology,' Judd trans p. 167.
[3] *Op. cit.*, p. 92.

clear that Wundt points directly toward a kinæsthetic explanation of rhythm.

While Meyer was investigating only speech rhythms, he seems to have stated positively that the consciousness of rhythm is not present until there is added to the perception of an objective series the feeling of bodily movement:

"Es sei ausdrücklich betont, dass, wo rhythmus und takt in frage kommen, es sich stets um bewegungsemfindungen handelt. Nicht der, der einem tanzenden zusieht oder einem ein lied rezitirenden zuhört, sondern der tanzende, der rezitirende selbst hat die unmittelbare emfindung des rhythmus. Gesichts- und gehörseindrücke vermögen nur mittelbar die emfindung des rhythmus zu erwecken, insofern diese eindrücke nämlich, von rhythmisch bewegten gegenständen hervorgerufen, bei dem emfindenden selbst rhythmische bewegungen des körpers auslösen. Es ist nicht nötig, das die bewegungen wirklich nach aussen hin sichtbar werden, obwohl dieses oft trotz des zwanges, den die sitte ausübt, eintritt."[1]

Smith recognizes the presence of a motor accompaniment of rhythm, which she describes as expressing itself after a definite temporal and intensive scheme, and not perfecting itself freely as in the progress of the usual emotion.[2] In relation to the question whether the effect of rhythm on work is to be regarded more as physiological or psychological, Smith has this further to say about rhythm and movement: "The origin of rhythm is in general physiological, *i. e.*, the regular repetition of bodily movements is the physiological stimulus, whose mental product is rhythm."[3] Again, she says: "The sensation of rhythm which one has from listening to singing, to dancing or to reading, is entirely different from the sensation of rhythm which one has when he himself sings, dances, reads, etc. It appears true that the foundation of rhythm lies closer to the functions of the general organs of the body than to the special sense organs."[4]

Squire observes the intimate connection between movements and the rhythmic impression. She notes that one subject could only give a unitary character to the group when he was making a spoken group correspond to a complete wave of respira-

[1] 'Beitr. zur deutschen Metrik,' p. 37.
[2] *Philos. Stud.*, XVI., 291.
[3] *Op. cit.*, p. 294.
[4] *Op. cit.*, p. 297.

tion. The trochee grouping in reciting a repeated syllable was coördinated with a complete wave of respiration. In other cases subjects depended on different movements. She finds that 48 subjects, for example, nodded their head while speaking dactyls. More important still is her observation that 'absence of movement was generally correlated with imperfect grouping.'[1]

The most recent description of rhythm by an experimenter is that of MacDougall. In one place he recognizes clearly that rhythm cannot be felt without there being present a kinæsthetic accompaniment. He says:

"The bare auditory perception of a series of sounds, the uniformity of which is broken by periodic reinforcements, no more affords the peculiar experience of rhythm than does the perception of those visual symbols which represent the relations of such a series of sounds in musical notation. The successive stimulations must start a series of motor impulses somewhere before the rhythm is felt. Apart from such a pulse of bodily change the perception of a rhythmical series of sounds would be the bare abstract apprehension of their varying intensities and intervals."[2]

In another place he says:

"We may conceive the succession of auditory stimulations to arouse a parallel motor accompaniment in the form of sensation reflexes occurring in some part of the bodily organism. The perception of rhythm under this conception is due to the kinæsthetic sensations whereby periodic elements of the primary auditory series are reinforced in such a way that the whole sum of sensational material rhythmically increases and decreases. * * * Here, also, there is present in consciousness a real series, but it is the accompaniment, not the original sequence of sensations, which is thus characterized."[3]

While MacDougall thus observes that rhythm is not felt without these kinæsthetic sensations, he goes further and conceives, as I have noted before, that the impression of rhythm is somehow also bound up with a constant nerve or brain pulse, *i. e.*, with a real change in the 'original sequence of sensations.' It is to this I would object. If he meant by a 'rhythmic functioning' of the nervous system the fact that there would be a rhythmic nerve current if we had rhythmic movement, of course I should agree. He seems, however, to hold that the rhythm of the nerve current is a constant organic rhythm continuing all the time. It comes in to reinforce certain of the

[1] *Op. cit.*, p. 79 ff.
[2] *Psychol. Rev.*, IX., 464. See also *Monog. Sup. Psychol. Rev.*, IV., 325.
[3] *Psychol. Rev.*, IX., 465.

original auditory elements. This I have objected to, together with other organic rhythms, on the ground that it would be a constant. That MacDougall includes both the kinæsthetic sensations arising in the presence of the outer stimuli and this constant nerve functioning in his explanation is shown in his summary which follows the statements quoted. He says: "Both of these relations between the rhythmically repeated stimulation and the nervous activity, namely, functional facilitation and reflex motor discharge, I conceive to be represented in the conditions which support the impression of rhythm."[1]

We see that MacDougall would thus explain rhythm in part by actual changes of the primary sensations and in part as illusion from the kinæsthetic accompaniment. In voluntary subjective rhythms we have little or no evidence of a real change in the intensity of the auditory sensations due to the period of nerve functioning. I believe it is better to hold, therefore, that the impression of rhythm arises only from the kinæsthetic sensations.

Stetson[2] offers some excellent 'suggestions for a motor theory of rhythm' in a paper which has just appeared. He outlines the application of such a theory to speech rhythms, but without committing himself to it. Assuming a motor explanation, he regards the feeling of 'tension between positive and negative muscle sets' as the conscious factor 'whereby all the beats of a period seem to belong to a single whole.'[3]

From the above references to various investigators it is plain that kinæsthetic sensations have from the first been observed in the background of the rhythmic impression. MacDougall approaches most nearly the formulation of a kinæsthetic theory, although others have hinted at it. I believe that it is time to recognize that it is this element in the conscious experience which adequately affords the explanation of the main fact of rhythm, the group feeling. To be sure we should not stop here. There are many other attributes of the rhythmic impres-

[1] *Ibid.*

[2] 'Rhythm and Rhyme,' *Harvard Psychological Studies*, I., 413-467; *Monog. Sup.*, *Psychol. Rev.*, IV., 413.

[3] *Op. cit.*, p. 455.

sion to be accounted for. There are questions of accent, of the genesis of rhythm, of the limitations of grouping, etc., to be investigated. The advantage of the kinæsthetic thesis which is offered here is that it gives a satisfactory mode of approach for these other problems. I do not expect to enter into the discussion of these problems at any length, but merely to point out the bearing which the kinæsthetic point of view would have on them. The rhythmic grouping, for example, must be limited by conditions which interrupt the kinæsthetic sensations, such as fatigue or the predominating influence of other sensations in consciousness. This furnishes a key to testing suggestions as to why grouping is lost below and above certain limits.

The question whether accent is necessary to the rhythmic impression has been a matter of some dispute. So far as the thesis which I am defending is concerned it is not a question of vital importance. Sensations of movement and tension may concur as well with an accented as with an unaccented group. They explain intensity changes in the units as well as temporal crowding of the units into groups. Meumann notes that with Hauptmann, Westphal, Lobe, Herbart, Schopenhauer and Lotze rhythm is conditioned by temporal connection of the units; while with Kostlin it depends upon accent.[1] Meumann himself, as well as Wundt and MacDougall, regards an accentual as well as a temporal connection to be necessary.[2] Squire is the most recent investigator to note the presence of rhythm without the perception of accent. Indeed, she regards the non-accented group as most early developed in the child, so far as its ability to speak rhythms is concerned.[3] My own subjects, both in observing sounds and lights, have often mentioned rhythmic groups set off by longer intervals without noting any difference in the units. It seems clear that it is not necessary to perceive accent in order to get the full grouping impression and affective tone of rhythm. Moreover, it is possible to conceive a movement sensation accompanying an auditory series and setting the sounds off into groups by like stages in

[1] *Philos. Stud.*, X., 250.

[2] Meumann, *Philos. Stud.*, X., 303. Wundt, 'Physiol. Psychol.,' 4te Aufl., II., 88 ff. MacDougall, *Psychol. Rev.*, IX., 460.

[3] *Op. cit.*, p. 50.

its wave without an illusion of accent. On the other hand a repeated increase in force of movement might easily be interpreted as an objective accent. I prefer, then, to hold that accent is not necessary to the rhythmic impression, although it is commonly present.

On the kinæsthetic basis the pleasure from rhythm is accounted for in rather suggestive ways. Squire, for example, has suggested that the pleasure arises first from the pleasure in mere activity. "The great pleasure which children find in rhythm is due to the efficacy of rhythm to set up vibrations in other organs of the body, and the consequent harmonious activity of the several bodily organs. The affective tone increases in proportion as the summation of excitation increases, till a state bordering on ecstacy may be reached."[1] MacDougall suggests that we take greater pleasure in certain rhythms because of the 'coincidence of subjective and objective change.'[2] We may say that we have a biological ground for pleasure in rhythm whenever we show that its tensions and movements favor the regular organic rhythms. The coincidence of both means a favorable condition for the individual and hence pleasure arising in a truly purposive way.

If we approach a genetic explanation of rhythm from the point of view I have outlined, we are ready both to describe the manner of origin and the use of this phenomenon in our mental life. Since it requires both objective stimuli and kinæsthetic sensations for its perfection, we recognize that the rhythmic experience arose only when the 'outer' sensations in series became accompanied by movement or tension. Under the general tendency of processes to repeat themselves[3] this developed into a regular perception of the sensations as grouped. The impression might first have arisen from a grouping by one of the prominent regular bodily rhythms like breathing and then been carried over into other movements. Bücher regards poetical and musical rhythms as developed from movements accompanying work.[4] The purpose of rhythm in mental evolution

[1] *Op. cit.*, p. 98.

[2] *Psychol. Rev.*, IX., 465.

[3] MacDougall, *Psychol. Rev.*, IX., 469.

[4] 'Arbeit und Rhythmus.'

might well be said to be the aid it affords in making automatic the perception of like events in series. A mental act which becomes automatic allows us to increase the range of contemporary activity. 'Economy of attention' or increased 'span of consciousness' are certainly results worthy of survival.

Psychological Summary.

In this discussion of rhythm from the psychological side it is apparent that physiological considerations have constantly come in. On account of the nature of the thesis offered it seems impossible to completely exclude them. This is especially true in considering the bearing of constant organic rhythms on the explanation. In summarizing this discussion, however, we can keep well within psychological terms. As the simplest description of rhythm we would say that it is the uniform recurrence of sensations of movement or tension concurring in regular periods with sensations from an objective series of stimuli. We reject the explanation of the main fact of rhythm — the unitary feeling of the group — on the basis of regular organic rhythms or on the basis of attention. We try to simplify Wundt's terms 'expectation and satisfaction' to tension and movement sensations. We refuse to classify rhythm as either a pure perception or pure emotion. In brief we say:

Rhythm is the uniform perception of successive groups of objectively localized sensations, accompanied by a characteristic emotional tone (the sensations of movement and tension coincident with the perception of the objective series). These kinæsthetic sensations provide the factor by which the unit sensations appear bound into groups and at the same time give the peculiar affective tone of rhythm. The perception is limited to sensations which follow not too rapidly to permit the kinæsthetic accompaniment to arise, nor too slowly to permit it being broken by other sensations. The most pleasurable rhythm is that in which the kinæsthetic sensations are reinforced by sensations accompanying the regular bodily rhythms, *i. e.*, when the two coincide. Genetically rhythm arose with the coördination of regular movement sensations and more rapid serial sensations. Biologically it was fostered because serving the purpose of economy.

B. From the Physiological Side.

1. *Demonstration of an Involuntary Movement Correlate of Rhythm.*

Turning more particularly to the physiological aspect of rhythm, I will first present my own experimental work with muscular responses to serial stimuli. The results furnish evidence of a physiological character bearing out the kinæsthetic explanation of rhythm which I have offered in the preceding pages. I began by investigating the effect of a series of like sounds on the muscular system, expecting to show that the stimulus after reaching the brain was, in some cases at least, diffused to the voluntary muscles. This would merely be an interesting demonstration of the generally accepted hypothesis of psychology, 'no impression without expression.' The research took on a more important character, however, when I found not only this diffusion, but also that the muscular responses did not agree with the incoming impressions. Instead, they combined the stimuli into temporally uniform group waves. Here I believed that I had found a rather complete correlate for the subjective perception of rhythm in a uniform objective series, and at the same time provided a graphic demonstration of that physiological condition.

Method of Experiment.

Before taking up my experiments in detail I desire to give some suggestions as to the difficulties to be overcome in getting satisfactory involuntary curves from the muscles. While the troubles encountered in my first work now seem less serious, it required many months of experimenting before they were obviated. Even at the present time it is by no means a simple matter to get an involuntary muscle curve showing grouping. For this reason I have reproduced a number of my curves in the plates as samples. The first and chief trouble which I met was the difficulty in getting a characteristic normal line when the subject's muscles were in such a state of unstable equilibrium that the sound stimulus would cause a movement. Breathing and the heart beat, as well as numerous accidental movements

of the body, head and limbs, showed themselves often in the normal line. Unless these can be eliminated by finding some muscular response where they are not also recorded, or which is plainly distinct from them, they will obscure the results. It is very desirable that the instruments should record a straight normal line when the stimulus is removed. This I succeeded in doing in the case of hand and forearm movements. Where the record was taken of head movements, breathing and accidental motions disturb the normal line, not sufficiently, however, to make it difficult to distinguish the stimulus line and its characteristics. I may say that I have made quite extensive tests with various parts of the body and have found a movement of the hand and forearm and movements of the head to be most satisfactory for this work. I have tried movements of the foot, of the leg, of the full arm, both with the subject standing and with him sitting; also movements of the tongue, all with comparatively little success. Somewhat to my surprise I could not succeed in registering a change in the squeeze of the hand, when a receiver was clasped in the grasp.

Another difficulty which my long experimenting, extending more than a year at interrupted intervals, convinces me will probably never be entirely overcome, is the impossibility of getting any involuntary movement curves from some subjects. In other words, I believe that not all subjects can relax themselves sufficiently to stop inhibiting their involuntary tendencies to move. Altogether I have tested at length fourteen subjects. From five of these I could get no results whatever. The reason for this I will discuss further on.

The sound stimulus which was used in these experiments was given by a metronome placed on the table beside the subject. The bell attachment was used when I wished to give an accented rhythm. The ordinary beats of the metronome were sufficiently uniform for the subjects to subjectively group them in twos or threes. The fact that the subjects easily accepted the illusion that every third beat was accented shows that the sounds were uniform enough for my purpose.

For recording the movements of the subject I have used two different methods. In the greater part of the work I used a

receiver consisting of a light sponge, about half the size of the closed fist, inclosed in a thin rubber air-tight bag.[1] This was connected to a Marey tambour. I tried numerous forms of receivers, including the bell-shaped pneumograph and various rubber bulbs; but the sponge was the most satisfactory, as it could be adjusted to the hand in any position so as to fit snugly. The other method, with which I took a few of the later head records, consisted in passing a thread directly from an object held in the mouth of the subject to the recording pen. The thread was held taut by a thread passing in the opposite direction from the recording lever over a pulley and pulled by a slight weight. This could be easily accomplished, as the pen was adjusted to write on a horizontal kymograph, the subject sitting opposite one end of the drum.

The first records were made on a kymograph using smoked paper, but at Columbia University I substituted an ink record on a continuous-roll kymograph. This was possible by using a glass pen which fed by capillary attraction from a small ink-well attached to the tambour. This form of pen has been used in psychological research by Wissler, Bonser[2] and others. It may be drawn out from a small glass tubing and is so convenient that it deserves wider adoption. The pen may be attached to electric markers or used with the tambour for recording blood pressure, pulse and breathing.

When experimenting on a subject I had him sit beside a table on which one hand rested. The outside edge of the hand was down and acted as a sort of fulcrum on which the hand might sway sideways with ease. The subject's elbow rested on the arm of his chair so that the position was comfortable. This position was chosen after much experimenting, as it was the only one found in which no movement was recorded except when the metronome was beating, and which was yet sensitive enough to get a result with certain subjects under the sound stimulus. The bending of the elbow and resting of the hand seemed to obviate respiration and other movements. The sub-

[1] Suggested by Dearborn and Spindler, 'Involuntary Motor Reactions to Pleasant and Unpleasant Stimuli,' *Psychol. Rev.*, IV., 453.

[2] 'A Study of the Relations between Mental Activity and the Circulation of the Blood,' *Psychol. Rev.*, 1903, X., 120.

ject was told to relax all his muscles as much as possible and then listen to the metronome, with eyes closed. After he had listened awhile to the beats I asked him if the sounds seemed to vary in any regular way. He generally at once noticed the grouping. Having made sure that the subject perceived a subjective rhythm I then watched for involuntary movements. If found at all they usually appeared in the hand or head. The subject was sometimes wholly unconscious of the movements. In any case it was necessary to be sure that the movements were not voluntarily made. The question whether the movements were involuntary was not troublesome on account of the trustworthiness of the subjects chosen. It could be judged by the attitude of the subject as well as his statements. The subject was always cautioned not to make any voluntary movements.

The Individual Records.

Subject *A*. A senior, male, at Minnesota University. He was able to relax himself exceptionally well and I obtained a very complete series of curves of the hand and forearm movement by the method described above. The effect was recorded when the metronome was beating without the bell attachment at the speeds 40, 66, 120 and 200 per minute. At the speed 40 the record (Fig. 1) shows one muscle wave for each beat. This is changed to one wave for two beats at the speed 66 and one wave for four beats at the speed 200. In another record with the same subject I found the grouping by fours at the speed 120. I also found that at another time he grouped the 40 speed in twos. Again, we find that when the bell of the metronome was added to every alternate beat at the speed 66 the record shows a single wave to each stimulus instead of one wave covering two stimuli as before. The same result followed this speed when the bell was added to every third and to every fourth beat, with the difference that when the bell was on every fourth beat the wave corresponding to the accented beat is noticeably higher than for the others. The subject was certain that the movements were not voluntary. To quote from him: "I was conscious that my hand was not still, but usually did not realize that it was making any regular movement. The motions were at no time voluntarily made." The early records with this subject were obtained without my suggesting in any way to the subject that he think of the sounds as grouped. He was told merely to listen to the sounds and relax himself. It was after the records that I found that the sounds had appeared in rhythms to the subject.

Subject *B*. Graduate student, male, at Columbia, a trained introspector. No regular effect was noticed for his hand, but the head movement was pronounced and I recorded that by the thread passing to the writing lever in the manner described above. The subject could easily think of the sounds as grouped in twos or threes, in which case the first sound of the groups appeared to be accented. Curves of this subject are shown (Fig. 2) when he was group-

ing by twos with the speed of the metronome 120 per minute, and for a three-group when the speed was 72; also for an objective two-rhythm, the bell producing the accent, at the speed 120. All of these curves show one wave to the group. An interesting variation is shown in curve *C*, an objective two-rhythm

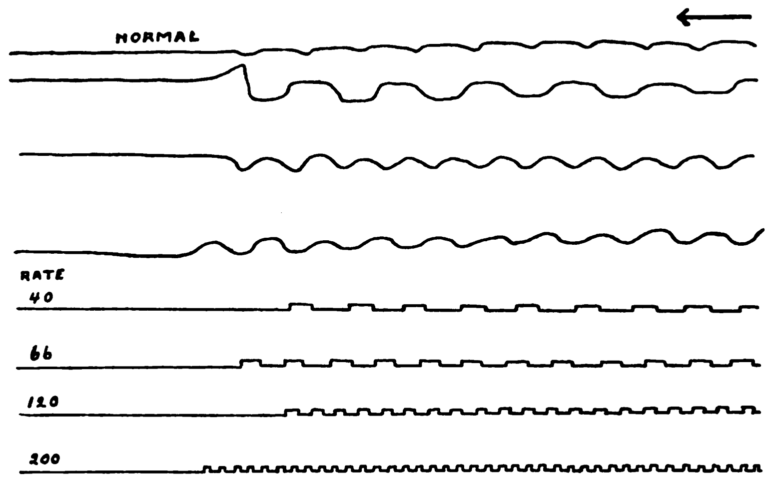

FIG. 1. Involuntary rhythmic movement of the hand. Subject *A*. Curves read from right to left. Reduced to one half original size.[1]

with the speed 120, *i. e.*, the bell sounding on every alternate beat. In this case the general wave of the group shows a higher rise for the accented sound followed by a lower rise for the unaccented, but both combined in a group swell. *B*'s introspection was as follows: "I can easily group the sounds of the metro-

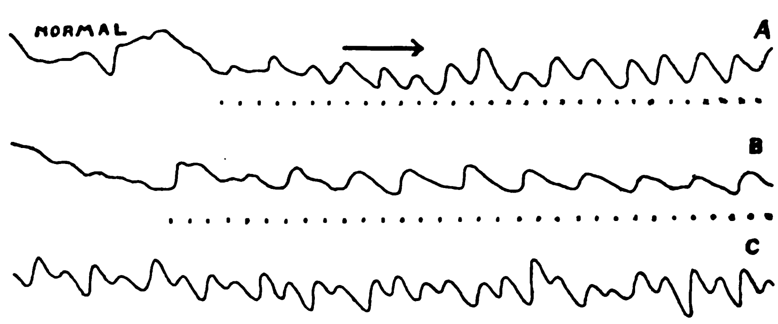

FIG. 2. Involuntary rhythmic movement of head. Subject *B*. Curve *C* shows the typical effect of an objectively accented rhythm. The dots are drawn in schematically to show the position of the stimuli. Curves read from left to right. Reduced to one third original size.

[1] The muscle curves shown in this and the following figures were accurately traced off from the originals. This was found necessary in order to print them in a satisfactory manner.

nome in either a two- or three-rhythm. The first sound in the group seems to be a little louder. When I relax myself and do not inhibit the tendency to movement which each sound seems to start in me, I am conscious that I am moving; but this movement is in no sense voluntary. Several times I was quite unconscious that it was regular at all, or that there was a movement for each group of sounds." After curve *A* was traced subject *B* stated that he was entirely unconscious of any uniform movement of his head.

Subject *C*, female, junior at Minnesota University. Curves were obtained for her hand movement, similar to those of subject *A*, but not so pronounced. A curious individual peculiarity in her case was the fact that, even when the metronome was beating at its slow speed of 40 per minute, she did not show a separate wave to each stimulus. Two beats were always included in each muscle wave up to the speed 112, when she changed to a grouping of four beats to the wave. The grouping movements were noticed without any suggestion on the part of the experimenter and before the receiver was adjusted in place. The subject, when cautioned against voluntary movements, stated positively that her hand was moving entirely without her control.

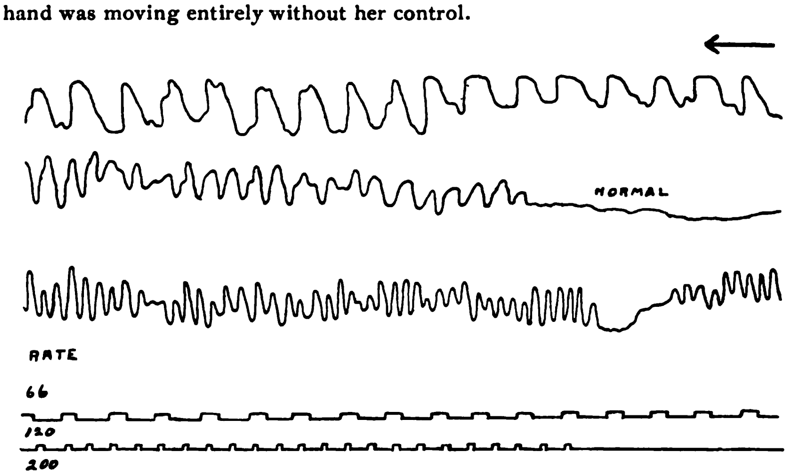

FIG. 3. Involuntary head movement, one wave to each stimulus even at the rapid rates. Subject *D*. Curves read from right to left. Reduced to one half original size.

Subject *D*, male, a senior at Minnesota. He showed no movement that I could detect with his hand, but had quite a pronounced head rhythm under stimulation. On account of its character it could not, I believe, be duplicated voluntarily. He was to outward appearances more relaxed than any of the other subjects I worked with. To this fact may be attributed the peculiar effect obtained. Even at the highest speed of the metronome, 200 per minute, the record shows a separate muscle wave for each stimulus given. See curves in Fig. 3. If one tries voluntarily to keep up a nodding of the head at the rate of three per second, he finds it practically impossible. It certainly could not be accomplished without great effort and in this case was entirely without effort, virtually reflex in character. According to the subject's statement it was absolutely involuntary.

Subject *E*, instructor in psychology at Minnesota. No hand response detected. A record of his head movement was recorded using the sponge receiver. The record was satisfactory for the speed of 120 per minute, at which the subject showed one muscle wave for each two beats. The tests were not continued for other rates of speed.

Subject *F*, senior, male, at Minnesota University. No movement of the head or hand detected, but the subject was found on observation to be making a regular rhythmical movement of his eyelids. When questioned as to the movement the subject said: "I did not know that my eyelids were twitching or moving in response to the sounds. I was wholly unconscious of the movement." Two other observers in the laboratory confirmed the rhythmical movement of the subject's eyelids, but the movement was not registered on account of the special apparatus necessary.

Subject *G*, assistant to the instrument maker at the Columbia laboratory, gave no results with the hand and only rather uncertain results with the head. His normal line was so disturbed that it obscured in most cases the effect of the sound stimulus. A grouping appeared at times, but so irregularly that little definite can be said about it. The thread recording method was used.

Subject *H*, graduate student, male, at Columbia. One good curve was obtained with this subject. It was a record of grouping with the head movement when the bell was sounding on every alternate beat at the speed 184. The grouping includes two bell stimuli for each wave. The bell probably caused the movement where the beat of the metronome failed. This was the only satisfactory curve obtained after many trials with this subject. The record was made directly by the thread attached to the tambour lever.

Inhibited Responses.

A series of curves which I obtained from one subject has a direct bearing on the question why we do not obtain involuntary muscle waves from all. Normally this subject, *J*, gave no response whatever to the metronome beat with her hand, head or body. She tried to relax her muscles completely, but still there was no movement. The remarks of my subjects and my own introspection seemed to me to explain adequately this non-responsiveness of certain subjects. Every person in his waking state tends to inhibit all random and involuntary movements. We normally hold our muscles in some degree of tension. I am confident that this is true of myself, even when I try to let myself relax as much as possible. If it were not so, every stimulus affecting us would doubtless cause useless movements which would seriously disturb us in our work. Dearborn and Spindler in studying involuntary motor reactions to pleasant and unpleasant stimuli noted that 'some subjects seemed constitutionally averse to any motor reaction.'[1] In the second

[1] *Psychol. Rev.*, IV., 454.

place it was apparent when I observed the subjects, that some of them could relax themselves much more than others. Relaxation seemed to be accompanied by a let up in the 'inhibition process' by which our voluntary muscles are held quiet unless we will to move them. I concluded that, if this usual waking inhibition could be eliminated, I might be able to get results from a subject, where normally there was no such response discoverable. Hypnosis offered a rather promising method of completely relaxing a subject. Subject *J*, mentioned above, who was an instructor at Minnesota, and a trained introspector, was found to respond readily to the suggestion of sleep. Hypnosis was induced by looking at a bright object in the usual manner. When *J* was sound asleep she showed the usual hypnotic condition by accepting simple commands like, 'you cannot bend your arm,' etc. I then started the metronome and merely told her to listen to it. Her hand, resting on the table, now seemed to be giving spasmodic jerks. These were, however, quite irregular. I placed the receiver against her hand and directed all my attention to that, so far as the subject could tell, for she had her eyes closed. In the normal waking state this subject had only been tested for hand movements, although I watched for others and found none present. I had never suggested nor discussed with this subject the possibility of any form of response other than the hand. I dwell on this to emphasize the fact that so far as any suggestion had been given the subject it was for an expected movement of the hand. This seems to me important evidence that the results afterward obtained were not the result of suggestion. While still trying to adjust the receiver to record the uncertain hand movements, I noticed that the subject's head was moving decidedly. On studying these movements carefully I noticed that they showed the muscle-wave grouping exactly like that I had obtained from other subjects in the normal state. After I was sure of these observations, I adjusted the receiver to the subject's head and made the tracing *a*, Fig. 4. The first curve was made with the metronome beating 66 per minute, without the bell attachment. The only direction given the subject was to listen to the sounds. The wave shows the charac-

teristic grouping by threes. The speed was then changed to 120 and the subject was told to listen and not move her head. The group wave disappeared at once. Then the subject was told she need not inhibit the movement of her head. The result was at once a muscle wave for every four beats. When told not to move her head the muscle wave again became straight. See curve *b*, Fig. 4. The direction to inhibit movements at once produced the straight line like that of the subject under stimulus in the normal waking state. After stopping to replenish the smoked paper on the kymograph, I set the metronome at 120 and said nothing to the subject. All this time it should

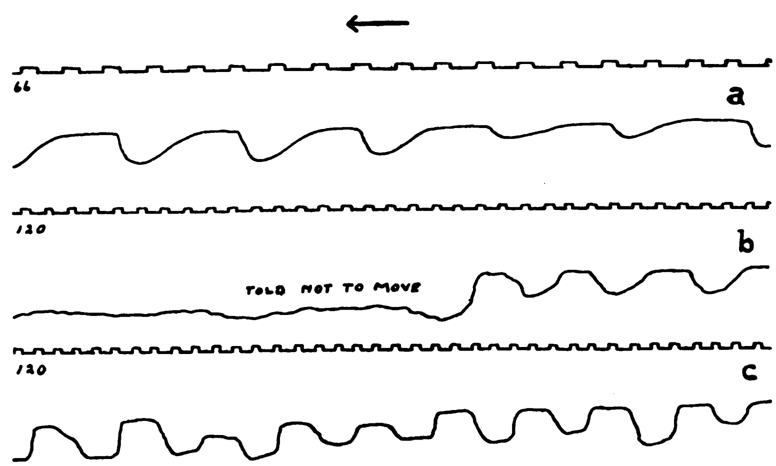

Fig. 4. Rhythmic head movement under hypnosis. Subject *J*. Curves read from right to left. Reduced to one half original size.

be remembered that the subject's eyes were closed, so that she had seen none of the tracings on the drum. Without any direction the subject again took up the grouping in fours. I next tried to determine whether the subject could be made by suggestion to group these beats in twos instead of fo[illegible] I told her to respond to every two beats [illegible]nted the beats '1, 2, 1, 2, 1, 2,' etc. [illegible]ake her abandon the four-grouping [illegible]g. 4) shows an interesting tendency [illegible]wave to each two beats, thus sub[illegible]e speed to [illegible] minute I tr[illegible]

a head movement for each stimulus. This again was impossible, although I counted '1, 1, 1, 1,' with the stimuli. She continued to make one movement cover two beats as she had done before without suggestion. Finally I suggested that she group these beats in fours and the suggestion was immediately responded to by a movement wave extending over four beats. The same thing occurred with a three-grouping. I stopped counting the beats after a few groups and the subject continued to preserve the wave movement to three beats.

Summary of the Muscle Curves.

The empirical results which we may gather from these curves may be summarized as follows: (1) The diffusion of the metronome sound stimulus to the voluntary muscles, under some circumstances, is demonstrated. (2) Without voluntary direction these movement responses under subjective rhythmic conditions are something more than one response to each stimulus. They take the form of one muscle wave covering a group of stimuli. (3) These rhythmic muscle waves vary at different times in the same individual as to the number of unit stimuli which they embrace (see Subject *A*). They also vary with different subjects. Compare Subjects *A* and *C* as to the grouping at the speed forty per minute. (4) The form of the muscle wave is a smooth curve, or a curve which starts rather abruptly and sinks back more slowly. Under the latter form of curve, the longest part of the movement was between the last metronome beat of one group and the first of the next. This was the most common condition. (5) Muscular relaxation on the part of the subject seems to be a necessary condition for getting satisfactory results. Holding the muscles tense, as is done normally in the waking state, inhibits the movements. It must be overcome by sufficient relaxation or by hypnosis. When the relaxation was brought about by hypnosis, muscle waves were obtained where no response had previously been noted. See Subject *J*. This response was apparently without suggestion.

2. *Revised Physiological Explanation.*

When we undertake the explanation of any state of consciousness from a physiological point of view our purpose is to find

the organic conditions which correlate with that particular state. The connection of these bodily conditions and the external stimulus in a chain of cause and effect would then complete the explanation. The most characteristic feature of the experience of rhythm which demands explanation is the fact that stimuli, occurring regularly in series, appear in consciousness to be united into groups. In the psychological discussion we have found that kinæsthetic sensations would provide an adequate element for the group feeling, provided that it could be demonstrated that they were actually present. My experiments show movements to be present in certain cases in a form which correlates with what we have termed a group feeling. I have already referred to other investigators, notably Bolton, MacDougall, Meyer and Squire, who have observed motor accompaniments during rhythmization. A further quotation from Bolton states the general observation in a way with which nearly all observers would agree. He says:

"Most subjects felt themselves impelled by an irresistible force to make muscular movements of some sort accompanying the rhythms. If they attempted to restrain these movements in one muscle, they were very likely to appear somewhere else. * * * The most common forms of muscular movement were beating time with the foot, nodding the head or swaying the body. Subjects 3, 10 and 17 accompanied the rhythmical grouping by muscular contraction of the diaphragm and chest, and it was exceedingly difficult to restrain them. Other subjects counted inaudibly or made the proper muscular adjustments for counting. Slight or nascent muscular contractions were felt in the root of the tongue or larynx. Most subjects were unconscious of their muscular movements until their attention was called to them and subject 15 never became conscious of the rhythmical contractions in the eyelids."[1]

It may be a long step from explaining rhythm on the basis of movements which are sometimes present to explaining it always on a kinæsthetic basis. This apparent jump does not seem so great, however, in view of several considerations brought out in connection with my experiments. In the first place the muscle wave correlates with several attributes of the rhythmical impression which other bodily conditions that have been suggested do not. It varies, for example, in length of its period with the rhythm perceived. As the unit sensations come more rapidly the muscle wave includes more units just as the

[1] *Amer. J. of Psychol.*, VI., 234.

conscious group does. It varies at different times in its form of grouping for the same rate of stimuli. This variation was noticeable for the same individual and for different individuals. The wave appeared in both a purely subjective rhythmization and when an objectively accented rhythm was given. All these characteristics of the muscle wave point to its being a true correlate. Moreover, my experiments with inhibited responses indicated that because movement is not always observed probably does not mean that there is no muscular activity in such cases. As soon as the normal waking inhibition was removed we had movement manifested. Meyer has stated that the activity need not be visible in order to give the feeling of movement.[1] MacDougall makes an important observation in this connection: "Of greater prevalence but much more difficult of observation are contractions giving rise to sensations of strain in the throat, head, chest and limbs, tensions in the vocal and respiratory muscles, and above all the simultaneous innervation of opposed sets of extensor and flexor muscles producing alternate phases of rigidity and relaxation which do not affect the local relations of the organ in which they take place."[2]

Thus we may suppose that the inhibition of a movement would substitute a new condition of activity in the muscle, a condition of 'rigidity and relaxation.' These conditions would arouse kinæsthetic sensations as much as would actual movements, but here the sensations would be varying degrees of tension. I therefore include both tension and movement in describing the conscious element necessary to account for the group feeling. Mach has called attention to the fact that an attempted movement of the eyeball, when movement is actually blocked by a piece of putty in the socket, gives an effect similar to a movement performed.[3] Practically all subjects on careful introspection note at least a feeling of 'tendency to move,' even when they do not speak of strain or movement sensations. On better analysis this feeling of 'tendency' seems not different from a real tension sensation in some of the muscles of the body. There seems to be nothing strange in the fact that these kinæs-

[1] *Op. cit.*, p. 37.

[2] *Psychol. Rev.*, IX., 466.

[3] 'Analysis of Sensations,' trans. by Williams, p. 59.

thetic sensations are interpreted as changes in the external series: that objectively uniform sounds appear accented and grouped. We are familiar with the usual explanation of the vertical line illusion, that eye movements along vertical lines, because accompanied by more effort, make the lines appear longer. Considering all the facts, there seems to be as good reason in the case of rhythm to suppose that muscular activity (movement or tension) is at the basis of the impression.

This explanation of rhythm is to be supplemented by the supposition that memory of past movements may give the feeling of rhythm without actual repetition of the muscular activity. A man whose arm has been removed may at times still feel as if it moved. The effect is here explained as the excitation of brain centers by some associated tract. So we may suppose with rhythm that the kinæsthetic group feeling, formerly present with an actual muscular activity, is at a subsequent time merely revived in memory by association with the auditory sensations. Memory does not require muscular activity to be repeated. Rhythm would then be due solely to the memory of past activity. In the great majority of cases, however, the feeling of movement or tendency to move connected with the rhythmic impression is so distinct that it is difficult to suppose it can be a mere memory. In these cases a tension of the muscles seems very likely when movements themselves are not observed.

Analogies to the Group Wave.

Having gone so far as to suggest that the impression of rhythm depends upon a muscle wave or tension covering a group, we are called upon to show how it is that, if the stimuli come regularly, we can get a grouping movement. It is well to pass by the explanation of this rhythmical movement following an objective change in the series of stimuli or following voluntary grouping, in which cases the changing movement might be explained through factors connected with the stimulus itself or with volition. In the most important psychological aspect of rhythm, viz., involuntary subjective grouping, it seems to me we can suggest the direction in which we may hope to find the explanation, even if we cannot actually dis-

cover it. From the nature of the phenomenon it must be some structural arrangement of our body by which a series of like impressions, diffusing to the muscles, produces not a separate wave for each impulse, but a longer wave covering a group of impulses. Do we have any analogy for such a process? A number suggest themselves. In the first place the accompanying curve, Fig. 5, shows that in the case of electric stimuli applied to the thumb at intervals of .3 sec., one of the stimuli being slightly stronger than the succeeding two, the two like stimuli produced one wave with a break in its crest. This is just what we would expect under our hypothesis of grouping. In this case it appears to have been purely a reflex nerve and muscle action. Richet shows curves of muscular contraction when stimulating the cortex of a dog regularly with like

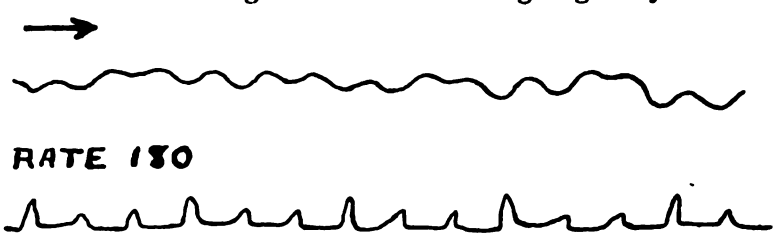

FIG. 5. Reflex grouping by the muscles of the thumb. Electric stimuli applied at the base of the thumb, every third slightly stronger. Subject *B*. Curve reads from left to right. Double the original size.

stimuli in which each alternate contraction is exaggerated, and finally in which there is only one contraction for every two stimuli.[1] The fatigue curves of Lombard show an analogous combination of muscular movements into groups in spite of attempted like voluntary contractions. He found that, after the second finger had fatigued while pulling every 2 sec. on the Mosso ergograph, it continued to show a rise and fall in the strength of its pull. A series of the same voluntary impulses thus produced a wave result. In this case, the succeeding waves are not of the same period, but they still show a grouping phenomenon under apparently like central stimuli. Lombard's wave result in the case of a continuous stimulus applied to a frog is of similar import. He says of this:

[1] *Revue Philosophique*, XLV., 341.

"In experiments made by the writer in Leipzig, 1884,[1] he found that if a constant temperature, high enough to cause reflex movements, but not so high as to rapidly destroy the tissues, were constantly applied to the skin of the leg of a decapitated frog, the resulting reflex action was not a continuous tetanus, but a series of tetani, which followed one another with considerable regularity. In the intervals between the tetani the muscles entirely relaxed, and the succeeding tetani were of nearly the same height. This phenomenon seemed to be dependent upon almost rhythmical changes occurring within the spinal cord."[2]

Bolton[3] refers to a number of similar analogies of grouped action under like stimuli. He cites Sterling to the effect that "submaximal stimuli following one another, even as slow as one per second, will produce a contraction after a time.[4] * * * Dr. Ward determined that between the rates of .4 and .03 sec. a contraction always followed a given number of stimuli. Above and below these limits the number might vary.[5] In the same line is the work of Drs. Kronacker and Hall.[6] It has been held by Sterling and others that when a stimulus is applied directly to the cortex, no matter what the rate, the brain sent out rhythmic impulses always at a constant rate."

Unless it should be said that after rejecting regular organic rhythms I am myself resorting to them for an explanation of rhythm, let me emphasize that I am here only speaking of analogies to the structural arrangement which I conceive must exist if repeated like stimuli are to produce a grouped movement. Muscular movements need not, however, be like the rhythmic brain pulse last mentioned in always being of the same period in spite of difference in the rate of stimulation. Because respiration, pulse, retinal rivalry, etc., show a constant period does not argue that the voluntary muscles may not have different periods of activity according as the stimuli come more or less rapidly. This period may vary again with the set of muscles in action. The above analogies indicate that the mus-

[1] *Du Bois-Reymond's Archiv*, 1885.

[2] *Amer. J. of Psychol.*, III., 41.

[3] *Amer. J. of Psychol.*, VI., 153.

[4] 'Ueber die Summation electrischer Hautreize.' *Leipzig, Berichte d. Sächs. Gesellschaft d. Wissenschaften*, 1874, p. 372.

[5] 'Ueber die Auslösung von Reflexbewegungen durch einer Summe schwacher Reize.' *Archiv für Anatomie und Physiologie*, 1880, p. 372.

[6] 'Die willkürliche Muskelaction.' *Archiv für Anatomie und Physiologie*, 1879.

cles may manifest periodic activity in the presence of serial stimuli. The muscle curves obtained by me indicate, as the kinæsthetic theory of rhythm demands, that the period of the muscle wave varies with each change in the outer stimulus and with the general condition of the subject.

No analogy, of course, proves that the grouping of like impulses in a waved muscular activity is what occurs in the case of listening to a series of like sounds. Analogies are important, however, as indicating that similar processes take place within us. They show that the present hypothesis in the case of the perception of rhythm would not introduce an entirely different physiological process. Moreover, I believe that my experiments supplement these analogies in the definite perception of rhythm and are in line with the direction from which most may be expected in connecting this experience with a physiological chain of cause and effect.

Limitations of Grouping.

It has been an ambition with nearly every investigator of rhythm to show that the limitations of rhythmic grouping and the favored length of group were dependent upon some particular bodily rhythm. For this purpose waves of respiration, circulation, attention, fatigue, the regular period of walking and various other physiological serial repetitions have been brought into the discussion. The result is far from satisfactory. The variations are so great and the evidence from different sources so conflicting that it is safe to say no definite connection has been traced, except possibly for the highest rate of stimuli at which grouping occurs. There are apparently three factors in the experience for which some source of limitation must be sought. (1) The fact that stimuli coming too rapidly cannot be grouped. (2) That the length of the group does not increase proportionally to the number of elements in it. How closely it tends to remain the same length is still uncertain. (3) That grouping ceases when the units are too far apart.

1. Investigators apparently agree that sounds must not occur faster than .1 sec. in order voluntarily to be grouped.[1] This

[1]Bolton, *Amer. J. of Psychol.*, VI., 237. Wundt, 'Human and Animal Psychol.,' Titchener and Creighton trans., 263. Squire, *op. cit.*, 85.

approximately coincides, as Bolton pointed out, with the average number of voluntary muscular contractions possible in a second, or, as Schaefer puts it, the 'consecutive nervous discharge from the cortical cells.'[1] Richet showed that the fastest rate at which separate like contractions were produced by stimulating the cortex of a dog was with stimuli .1 sec. apart. Faster than this there was a summation of stimuli.[2] He also calls attention to the fact that ten or twelve syllables are all that can be articulated in a second.[3] Another interesting suggestion has been made that .1 sec. agrees with the shortest time in which it is possible to attain a complete simple perception, *e. g.*, to distinguish a color from a group, as calculated by Cattell.[4] We seem to reach at this rate a fairly constant average as to the limit of central processes. We have here, then, not only a limit for rhythm but for any simple mental process dealing with successive activities.

2. The connection of a favored length of group with any particular bodily rhythm is apparently now in a state of almost pure conjecture. In the first place we know that the same individual varies greatly in the length of the group he chooses. To illustrate, Ebhardt found with free tapping that one subject varied at different times in the average speed of tapping a two-rhythm from a group length of .625 to 1.148 sec. While a three-rhythm was tapped by the same subject at different times with average group lengths from .940 to 1.803 sec.[5] Not only does the individual vary for the same group, but the two-group is considerably different from the three-group, as shown by Ebhardt and by the experiments of Miyake in tapping on a noiseless key and on a drum; also by Squire for repeating a syllable in trochee or dactyl rhythms. In Miyake's tables an average of the two-group with the first unit accented while tapping on a noiseless key shows a length of group about 1.2 sec. and for a three-group, 1.9 sec.[6] With Squire the length of

[1] 'Text-Book of Physiol.,' 1900, p. 798.
[2] *Revue Philosophique*, XLV., 342.
[3] *Ibid.*, 348.
[4] *Mind*, XI., 383.
[5] *Ztsch. f. Psychol.*, XVIII., 116, 118.
[6] *Studies from the Yale Psychol. Lab.*, X., 15.

the two-group in the different school grades varied in its average from 1.3 to 2 sec., and of the three-group from 1.8 to 3 sec.[1] Each of these figures is my average of their tables of averages from numerous trials. Of a different nature are the times for the preferred length of group when listening to sounds. Bolton gives a table showing the average for his subjects to be 1.59 sec. for the two-group, lowering to 1.16 sec. for an eight-group.[2] MacDougall finds that his subjects, while listening to sounds that varied in rate from .08 to 1 sec., chose groupings which varied in length of the highest group chosen from .917 to 2.5 sec.[3] Of course the results given above are not strictly comparable. The time of a group might be very different for free tapping than for subjective grouping when listening to sounds, or might vary with the kind of sound, etc. The important fact to be noted is that the group, so far as the experiments yet show, cannot be regarded as a period which may be said to have a favored length, even approximately. Averages under different conditions, when the subject chooses his own period, vary at least between .9 and 3 sec.

Looking at the matter from the other side, there is almost as much disagreement as to the length of the organic rhythms chosen as the correlate for the favored rhythmic period. Certainly there is variety enough, so that almost any group period might find a correlate somewhere within the limits. The 'wave of attention,' for example, was fixed by Lange for light stimuli on an average at 3.4 sec.;[4] by Münsterberg at 6.9 sec.;[5] by Lehmann at 12.8 sec.[6] For sound and electric stimuli it is still different.

Lombard found no regularity in the period of fatigue and reinforcement of a muscle.[7] In 90 per cent. of 2,000 cases the normal respiration wave was from 2.5 to 4 sec. The average pulse rate for adult males is 72 and for females 80 per minute.

[1] *Op. cit.*, table 42.
[2] *Amer. J. of Psychol.*, VI., 214.
[3] *Monog. Sup. Psychol. Rev.*, IV., 329.
[4] *Philos. Stud.*, IV., 404.
[5] 'Die Schwankungen der Aufmerksamkeit,' Beiträge II., 69.
[6] *Philos. Stud.*, IX., 79.
[7] *Amer. J. of Psychol.*, III., 29.

The rate of the full double swing in walking has been placed at .664 sec. on the average.[1] Stevens found the vaso-motor wave varied in length from 5 to 20 sec. while his subjects were making time judgments.[2]

Bringing these facts of the period of grouping and organic rhythms together shows at once how misleading it is with our present knowledge to claim that there is a standard length of group or that the normal group depends upon respiration, fatigue or any particular physiological rhythm as determining its natural length. Before this question can be settled we must find out if there is a favored length tending to hold under varying conditions. If an average period can be found with a comparatively small variability, we shall be ready to see if it lies within the limits of any single bodily rhythm.

3. As to the time which the sensations may be apart and yet be grouped, there is considerable difference of opinion. Bolton fixed it at 1 sec. but he was thinking particularly of involuntary rhythm.[3] Wundt sets it at 4 sec.[4] and MacDougall at 1.5 to 2 sec.[5] I would suggest that this limit is probably set by some bodily rhythm which comes in so forcibly as to interrupt the impression of rhythm coming from a kinæsthetic source. A change in respiration might cause such an interruption, or the limit may be a fatigue for this particular state of tension or movement. Until there is some agreement as to the limit it is rather fruitless to conjecture further about its physiological accompaniment.

Effect of a Motor Explanation.

In concluding the part of this paper devoted to the physiological side of rhythm I wish to call attention to some of the advantages and effects of the revised explanation which I have offered. It shows the uselessness of trying to demonstrate that subjective rhythmic groups of widely varying length are corre-

[1] For these rhythms see Schaefer, 'Text-book of Physiol.,' I., 747; II., 102, 269.

[2] *Amer. J. of Psychol.*, XIII., 26.

[3] *Amer. J. of Psychol.*, VI., 237.

[4] 'Human and Animal Psychol.,' Titchener and Creighton trans., p. 263.

[5] *Monog. Sup. Psychol. Rev.*, IV., 322.

lated with any regular organic rhythm which has an approximately uniform period of its own, like the pulse or breathing. It gives a place for bodily rhythms in explaining the tendency to favor groups of a certain length and for other limitations in grouping. In this connection it suggests that greater pleasure arises from objective rhythms which most nearly coincide with our normal organic periods. The motor explanation of rhythm holds as well for rhythms which are given objectively as those in which no impulse for grouping is directly given by the external stimuli. As for subjective rhythms it correlates both for involuntary and voluntary grouping. In considering the form of the rhythmic group this explanation on the basis of muscular response is suggestive, not only as to the number of units within the group, but also as providing a simple account of the appearance of accent through stronger muscular action. We have already noted that the muscle wave theory is helpful in explaining the origin and development of rhythm. Finally, I wish to emphasize particularly that the motor explanation of rhythm destroys, in my opinion, all reason for supposing that the experience of rhythm is limited to two sense orders, hearing and movement, as has been often assumed. There would be no reason *a priori* why a series of stimuli addressed to any sense should not produce an experience of rhythm. I am quite confident that they would under proper circumstances; that rhythms of smell, taste, touch or vision are just as possible as rhythms of hearing. It will be one of my tasks in the next part of this paper to give some introspective evidence showing the presence of the rhythmic impression from serial light flashes. This visual rhythm, in my opinion, is identical in all its essentials with rhythms of sound.

PART II. VISUAL RHYTHMS.

1. Is Rhythm Limited to Hearing and Movement?

This question is raised by the general supposition among writers on rhythm that this particular experience is confined to certain orders of sense. Külpe says: 'It is a curious fact that the involuntary rhythmical apprehension of stimuli is confined to auditory impressions.'[1] Titchener leaves out the qualification 'involuntary' and says positively: "There are only two classes of sensation that can form the basis of the perception of rhythm. These are the auditory and the tactual or 'motor'; there can no more be, *e. g.*, a visual rhythm than there can be an auditory symmetry."[2] Squire says that rhythm 'appears to be a phenomenon characteristic of but two modalities, audition and movement.'[3] Meumann says we do not know why rhythm is limited to definite sense fields.[4] He apparently inclines to extend the experience in a lessened degree to other sensations than sound and movement. He suggests that: 'Jedes Sinnesgebiet um so mehr an den rhythmischen Erscheinungen Theil nimmt, je mehr und je exclusiver es Organ der Zeitschätzung ist.'[5] Hearing, being the best sense for time, is most adapted for receiving rhythmic impressions. Movement, serving also for space valuation, is less adapted; while sight, which is a dull sense for time and almost exclusively a space sense, he thinks is still less serviceable for rhythm. The only suggestion from the physiological side why we might consider rhythm limited in its field, is Mach's early conception that we have a special sense for rhythm which is localized in the organ of hearing.[6] Ewald describes a tonus organ for the muscles con-

[1] 'Outlines of Psychol.,' Titchener's trans., p. 389.

[2] 'Experimental Psychol., Qualitative, Student's Manual,' p. 174.

[3] *Op. cit.*, p. 85.

[4] *Philos. Stud.*, X., 249.

[5] *Op. cit.*, p. 261.

[6] 'Untersuchungen über den Zeitsinn des Ohres,' *Wien. Sitz.-Ber.*, 1865, II., 133.

nected with the labyrinth of the ear, which suggests a possibility of more intimate relations between hearing and movement than between other senses and the muscles.[1] Mach, however, gave up his theory of the ear organ for rhythm and referred time and rhythm both to a special energy of the brain.[2] Physiological suggestions, so far as they go, may then be regarded as reasons for hearing being a favored sense in rhythm rather than an exclusive sense.

My experimental work in visual rhythm has taken the nature of an introspective study. It has been directly concerned with this question of the limitation of rhythm to two sense orders. I wished to determine whether a series of identical light flashes might not also give the same experience of rhythm. I shall contend that the introspections of 26 subjects, with whom I have worked, show that we have an experience in the field of sight which is identical with that of rhythm in hearing so far as all the essentials of the experience are concerned. What we are dealing with is a specific psychological experience, described somewhat as I have attempted in the first part of this paper. It is not a mere analogy to sound rhythms, but a rhythm just as complete and direct as the rhythm we are familiar with in listening to the beats of a metronome. I shall treat of several phases of visual rhythm, especially its relation to kinæsthetic sensations. Involuntary and voluntary light rhythms in the forms and limitations of grouping will be shown to parallel partially the auditory perception of rhythm. So far as I am aware this is the first psychological work that has been undertaken in the grouping of light flashes. It is hoped that it may form an introduction to the field of visual rhythm, which offers numerous interesting side lights on this characteristic mental experience. As an introduction it can claim only that completeness which attaches to a preliminary investigation.

The subject of visual rhythm may be said to have been approached in a way from another side, where the investigator was dealing, not with series of lights succeeding each other in

[1] 'Untersuchungen über d. Endorgan d. Nervus octavus,' p. 294. Cited by Scripture, 'Elements of Experimental Phonetics,' p. 527.

[2] Cited by Meumann, *Philos. Stud.*, X., 267.

time, but with the grouping impression which we get from viewing a surface covered with dots, lines or figures. Smith contends that we can get no experience of rhythm from such visual stimuli as they exist beside one another in space.[1] Meumann would admit an indirect experience of rhythm from viewing architectural effects or artistic designs. He says: "Kurz, nur soweit räumliche Gebilde dem betrachtenden Subject mittelbar Veranlassung zu periodisch succedirender Betrachtung geben, können sie etwa Antheil nehmen an den rhythmischen Erlebnissen."[2] He considers that rhythm rests upon certain periodic alterations of attention and, therefore, rightly asks whether these alterations occur in the same way in case of viewing an artistic design when like elements appear as grouped. What we wish to know is whether the experiences are the same in quality, not whether the causes of stimulation exist at the same time or follow each other in objective time. It may be enough that the subject gets the stimuli successively by turning his eyes from one part of the picture to the next. For this reason it seems to me that Smith's argument against the possibility of what we may call artistic visual rhythm seems to be insufficient.

She speaks of the matter in criticising Billroth's conception of symmetry as 'resting rhythm.'[3] She says: "Das Wort Rhythmus bezeichnet dabei nicht mehr jenes charakteristiche psychische Erlebniss, welches der Mensch bekommt durch seine eigene Bewegung und durch Geräusche, die das Gehörorgan afficiren, sondern ein räumliches Nebeneinander."[4] To be sure there is a spatial adjacency of the elements in symmetry, but that is not the reason why symmetry is not a rhythmical experience. It is rather because here the actual experience of grouping is lacking. There seem to be good reasons for believing that the perception of groups among repeated decorative figures, lines, etc., is a real rhythmical experience depending upon the repetition of a like accompaniment of strain sensations. Schumann, for example, is positive that the groups appearing on a surface covered uniformly with dots are really

[1] *Philos. Stud.*, XVI., 200.

[2] *Philos. Stud.*, X., 262.

[3] 'Wer ist musikalisch?' *Deutsche Rundschau*, Oct., 1894, Sept., 1895.

[4] *Philos. Stud.*, XVI., 300.

perceived as units.[1] He explains this unitary character on the ground of attention and does not attempt to correlate it physiologically. In so far as these groups are units merely in the sense that any object because perceived at one time is a unit, we have no rhythmical quality in them to explain; but if the groups are really limited in complexity, as he claims, it would seem that the grouping depended upon some other factor. Schumann says of himself, when he views a field filled with small black squares, 'for complexes, which consist of more than sixteen elements, an indirect reproduction is no longer possible.'[2] Below that number of elements he finds grouping in various forms arising quite involuntarily. The fact that we may have to turn our eyes from one field to the next does not seem to prove that we do not get an experience of rhythm. The feeling of rhythm may be independent of this necessary turning of the eyes to get the next stimulus. If we turned our head after each sound of a metronome we would hardly say we were no longer getting a direct experience of rhythm. Moreover, the grouping of dots may arise within a single field of vision. If these groups have a distinct quality, something more than the logical conception of their identity, that quality probably depends upon some sort of accompanying kinæsthetic sensation. I am inclined to think that here too we have a rhythmical experience in vision, although it is much more difficult to trace out any correlate for the group feeling than in the case of serial light flashes.

2. Method and Apparatus.

In arranging my experiments it was desirable to be able to give uniform lights at regular intervals and to change the intervals, the duration or the intensity of the lights. It was also necessary to produce the flashes in a form that would reduce, as much as possible, the fatigue effects that accompany such experiments. At first I tried giving the flashes by revolving a disk containing openings in front of an electric lantern or of

[1] 'Beiträge zur Analyse der Gesichtwahrnehmungen,' *Ztsch. f. Psychol.*, XXIII., 25.

[2] *Op. cit.*, p. 26.

an incandescent light inclosed in a box. This is quite satisfactory, except that the flash is let on or shut off the field of vision by the moving of a shadow (the edge of the slit in the disk) across the screen. To obviate this appearance of movement across the field the method was changed and the lights produced by sending an electric current through an incandescent bulb for a small fraction of a second. The bulb was inclosed in a light-tight box and the light allowed to shine through a circular opening 4 cm. in diameter. This opening was covered with a piece of ground glass to diffuse the light uniformly. The subject did not look at the lamp, but at the flash as it was thrown against a white wall in front of him. The box containing the electric bulb was placed between the subject and the wall. It was slightly to the side, about three feet from the floor, with the light opening, of course, turned away from the subject. The flash, as it appeared on the wall, was about 50 cm. in diameter, brighter at the center and fading out toward the edge. This kind of light proved to be on the whole the best that could be devised. It was very much less fatiguing for the subject to look at the flash on the wall than to look directly at the light. Daylight was excluded from the room. By lighting the room by another 16-candle-power light, after-images of the flash were almost entirely avoided.

The incandescent bulb which produced the flash was lighted in the following manner. A special electric-contact wheel was devised. When rotated by a motor connected with a speed reducer, this wheel gave contacts of long enough duration to heat the filament to incandescence. A duration of .1 sec. was sufficient to give a rather faint flash. Under the speeds usually used the contact continued from .2 to .3 sec., which was considerably above the time necessary to heat the filament of the lamp to its maximum. A weak current from a single storage cell passed through the contact wheel. This instrument was in the circuit of a relay. The high potential current which lighted the lamp was made and broken by the relay simultaneously with the make and break of the contact wheel.

The contact instrument (see plate at the end of the thesis) consisted of a wheel of hard rubber, 22 cm. in diameter and 2

cm. thick, which was rotated on ball bearings. The contact was made by a flat brass spring (*S*), 15 mm. wide, resting on the rim of the wheel and touching at certain intervals a brass contact-piece (*C*), set into the edge of the wheel, level with its circumference. The brass contact was turned to exactly fit a groove in the rim of the wheel, 8 mm. square, which ran entirely around one edge of the circumference. The contact-piece was held in place by a bracket which caught into another square-cut groove on the flat surface of the wheel. This bracket was made to fit so snugly that it would hold in place without a screw. At the same time the contact-piece could be removed and placed at any point on the circumference desired. A scale of degrees was marked on the wheel to assist in this adjustment. The contact-piece was connected with the axle of the wheel by an easily-removed copper wire running to a metal plate at the center of the wheel. The current passed through the axle and out through one of the posts of the support. The noise of contacts was eliminated by having the spring contact constantly touching the rubber rim of the wheel, only part of it extending over the groove containing the brass contacts. The ends of the brass contacts were tipped with hard rubber to assist in preventing the noise of a click when the spring touched the contact. So long as the wheel did not rotate more rapidly than once a second, which was faster than any speed used, there was no noise from the contacts. This was a decided advantage, for it was then possible to have the subject in the same room with the apparatus. The only noise was the hum of the motor. This was constant and did not interfere with the experiments. So far as the purpose of this investigation was concerned, any errors in the duration of the contacts or intervals were so small as to be negligible. The smallest difference in the length of a .5 sec. interval which could be distinguished eight out of ten times was about .15 sec., while the average error of the interval, as tested by the chronoscope, was about .005 sec. The average error in the duration of a .26 sec. contact was less than .002 sec., while the smallest difference that could be distinguished by a subject eight out of ten times was about .015 sec. The speed of rotation of the contact wheel could be changed by belt-

ing to three different pulleys on the wheel or five different-sized pulleys on the last wheel of the speed reducer. This gave considerable variety in the rapidity of the lights, while the contacts could be shifted about the circumference of the contact wheel to further vary the intervals, if desired. For the experiments with subjective rhythmization two contacts 60° long were used. For objective rhythms, consisting of a long light and one or two short lights, one of these 60° contacts was removed and the short lights produced by 40° contacts. A change in the intensity of the flashes could also be made by intercepting a piece of opal glass in front of the lamp. In this case the box containing the lamp was placed behind the observer, so as not to disturb him. This of course enlarged the flash on the wall. The duration of the flashes and the length of the intervals will be stated in connection with each of the experiments.

There are many complications, physiological as well as mechanical, which are encountered in working with lights, that are not found with sounds. In the first place it is impossible to produce a light which will appear stationary. Even if a light the size of a pinhole flashes at intervals, it will seem to swell out from the center and then contract. The flashes on the wall had the same appearance. The explanation of this phenomenon seems to be physiological. Physically the flash covers the entire surface at the same time. Psychologically it seems first to strike more intensely at the center and afterward to spread uniformly with a gradual decrease in intensity toward the diffused circumference of a circle, where it fades into the light of the surrounding field. This appearance is reversed as the flash leaves the wall, the intense light at the center remaining to the last. This effect might be explained as due either to a central or a retinal process. We might suppose that the part of the retina on which the center of the flash falls is first excited, because stimulated by the most intense light rays. The less intense rays, although reaching the retina at the same time, take longer to overcome the inertia of the rods and cones on which they fall, and thus come later to consciousness. On the other hand, the entire appearance may be a matter of interpretation in the higher brain center. The currents from all parts of the retina

reaching the center of sight at the same time, we become first conscious of those which are most intense. The effect of this appearance of movement on the question whether we really have a visual rhythm I shall treat later in discussing the similarity of visual and auditory rhythm.

Another circumstance in connection with lights, which it seems impossible to eliminate, is that the light of longer duration always seems to be of greater intensity, at least within the limits of duration within which we can get a rhythmical grouping. By rotating a disk with different openings in front of an electric tuning fork it is possible to get sounds of different duration which still appear of the same intensity.[1] My experiments indicate that this is not possible with lights. The work of Lough shows that when the light is below its physiological maximum the intensity appears to vary directly with the duration of the stimulus.[2] Exner found that it takes .3 sec. or less for a light stimulus to reach its maximum. After that it loses in brightness from fatigue, so that at the end of .6 sec. it is only 70 per cent. as bright.[3] But this loss from fatigue is not the only factor to be considered, for I found, with lights seen in succession, that one which endured 3 sec. was invariably regarded as brighter than one which endured 1.5 sec. Longer duration thus seems to have a greater effect in interpretation than fatigue after a light reaches its physiological maximum. The greater quantity of light causes the subject to think it is brighter. Under such conditions it is apparent that similar psychological effects are produced by giving long and short light flashes as by giving bright and dim flashes. It is impossible to study the effect of an increase in the duration of a unit in the light group independent of an apparent change in intensity.

3. The Subjective Rhythmic Impression from Like Flashes of Light.

The question whether a rhythmic impression is obtained from a series of like flashes of light occurring at regular inter-

[1] Bolton, *Amer. J. of Psychol.*, VI., 229.

[2] 'The Relation of Intensity to Duration of Stimulation in our Sensations of Light,' *Psychol. Rev.*, III., 484–492.

[3] 'Ueber die zu einer Gesichtswahrnehmung nötige Zeit,' *Sitzgsber. d. Wiener Acad.*, 1868. Cited, Hermann, 'Handbuch der Physiol. der Sinnesorgane,' pp. 219, 224.

vals is to be determined by introspection. For my experiments I had twenty-six subjects, half of whom were completely naïve, not even knowing the topic of the research. Three of the subjects were women. All were advanced students at Columbia University, the majority having had considerable experience in introspection. We will first consider the introspections of naïve subjects before any suggestion had been given them of rhythmic grouping. This bears upon the question whether an involuntary rhythm is ever obtained from uniform lights. When beginning an introspection with a new subject extreme care was taken not to ask any questions which would suggest rhythmic grouping, or to have anything in the conditions surrounding the experiment that would bring up the idea of grouping. Later in the introspection, when no observation regarding rhythm was made, I asked suggestive questions, had the subject beat time to the rhythm, and in other ways endeavored to see if the impression of rhythm could be developed. For the introspections as to rhythm two different rates of lights were used. It was found that the subjects preferred not to have the flashes come as rapidly as .3 sec., which is considered a favorable speed for sounds.[1] The favored rate for lights seemed to be about .7 sec. apart, although some of the subjects preferred .5 sec. and were given that rate. The durations of the lights with these intervals were .3 sec. and .25 sec. respectively. These rates were chosen after experimenting with subjects who readily perceived rhythmical grouping.

a. Involuntary Rhythms.

The first direction given a naïve subject was: 'Describe your feelings as you look at the lights.' Subject 1, male, non-musical, at once noted what might be termed the accompaniment of a rhythmical impression. He said: "It gives me a feeling of suspense. I don't know whether you care about it, but for anything rhythmical like that I have a tendency to breathe for every three." Subject 9, female, musical, said: "There is an idea of rhythm in it, sort of swinging in the way it comes." (Question —

[1] Meumann, *Philos. Stud.*, X., 302. Squire, 'A Genetic Study of Rhythm,' p. 85, says between .3 and .6 sec.

What do you mean?) "Same idea as rhythm, perfectly regular, a pendulum idea, movement." At the next direction to the subjects, 'describe how the lights seem,' nothing else being said, Subject 9 continued: "*It is more intense sometimes than at others. Every other one that way, every other one more intense.*" The next direction to all subjects was: 'Describe the intervals.' This same subject, No. 9, said: "I think they are regular. No, they are not. Every other one is shorter." (Question — Do you feel quite sure?) "Yes, they appear that way." The above statements of Subject 9 taken with her subsequent introspection convince me that this subject perceived a very definite subjective grouping of the lights without any outside suggestion. Her attitude and manner of utterance, as well as her discussion of the matter afterward, made it quite certain that the rhythmic impression had arisen involuntarily, in the same way that listening to regular sounds gives rise to a grouping experience without conscious attempts at rhythm. The above statements are just what we would have expected if she had involuntarily grouped the lights. Too much emphasis can hardly be placed on the fact that no suggestion up to this point had been given the subject to group the lights or look for any regular changes in them.

With the next question we find Subject 1 more definitely noting a grouping. The question was: 'Do the lights and intervals always seem the same?' No. 1 said: "Some of the lights are more distinct. I haven't noticed whether that occurs at regular intervals. I couldn't say. It doesn't seem so." (Question — How about the intervals?) "They do seem much alike, but are very much affected by a tendency that has grown in my mind to count the lights in fours. They seem to be divided into sets of four. After every fourth is a better defined interval." (Question — In what way?) "The last light does not seem to fade into the next as the others do. The shadow seems to cut off so that the first of the next four seems to start more clearly defined." This statement, considered with the previous observation of this subject that he was breathing to every three lights and his comparison at once of the lights to 'the long rhythmical flash which seems to rise from the horizon at

sea into the sky,' indicates that No. 1 probably also involuntarily perceived a grouping. Of the 13 naïve subjects No. 6 is the only other one who can be said to have approached a grouping without outside suggestion. My next direction contained a direct suggestion of grouping. It was: 'Count the lights in twos to yourself. Do the lights and intervals always seem the same?' Subject 6 then remarked that he had noticed the grouping when he counted in twos before I had suggested it. He said: "Of course, if I count them in twos they seem to group in twos. The two come nearer together. At the same time, if I set my attention on the lights this disappears. Sometimes the first is brighter than the other. There is no regularity as to brightness. I might say that I had just noticed this before you asked the question." It is to be noted that both Nos. 1 and 6 grouped first without any accented light, but feeling the groups set off by a longer interval. I shall discuss this simplest form of rhythm later.

b. Voluntary Subjective Rhythms.

May the rhythmic perception of lights be developed in subjects, even when it is not at first noticed by them? To determine this question I tried two different methods of procedure. The first was to ask the subjects to count the lights by twos, *e. g.*, '1, 2, 1, 2, 1, 2,' and tell me if they noticed any difference in the lights or intervals. If this was unsuccessful I asked them to beat time with a baton to the lights, allowing them at first to choose their own method. When this did not give a visual grouping, I had them vary their beating so as to get a distinct group movement for accompaniment to the lights. Of the 20 subjects whom I carried carefully through this procedure in the same manner, 11 obtained a grouping impression from the lights at the first suggestion of counting. The others obtained the visual rhythm only when the counting was accompanied by beating time with the baton or some part of their bodies. With several the rhythm was uncertain and seemed to keep up for only a short time. Except the three subjects noted under involuntary rhythm, the impression was of course developed by indirect suggestions of counting or movement, although in all ex-

cept one or two cases the subjects observed the rhythmic impression themselves without my telling them to try to group the lights. The subjects would frequently say: "I feel as if I am making the lights appear in groups." In every case, however, the accompanying tension or movement was undoubtedly carried over into an apparent change in the light series itself. Among the more rhythmical subjects the feeling that the lights were really different often became very strong. In such cases the subject lost the feeling that he was grouping the lights; the impression became what might be termed an involuntary rhythm.

Difference in Subjects.

Almost the first thing that is to be observed in experiments with rhythm is the great difference in subjects. I suspect that this may be traced to a fundamental difference in the attitude of people during experimentation. , To the subject who turns out to be the most rhythmical, the lights appear as interesting stimuli the effect of which on himself he tends to watch and give way to. To the other class of subjects the flashes are specific units which are to be carefully judged and compared. Any apparent difference is at once to be severely weighed and criticised. A few instances will illustrate this difference among my subjects:

Subject 9, who perceives a light rhythm involuntarily, when I gave her an objective rhythm in which each alternate light was .1 sec. less in duration (very noticeably dimmer), grouped with the accent on the dim light and for some time called it brighter. She repeated this again a little later before I told her that she had reversed the objective difference in the lights. No. 1, another rhythmical subject, said regarding his attitude: "I have just let my mind go as sometimes when looking at a wall. I have not tried to be at all critical." On the contrary Subject 12 said: "I can imagine how an accented light would look if brighter, but it does not seem that way. I think that the real trouble is that I am wondering how they are." Subject 6: "As soon as I put my mind on the lights, I judge them." Subject 5: "I have cultivated a habit of letting things impress me, not trying to see how I impress them." Six of the subjects, when told to beat time to the lights, at once made one beat to each light. This put them in a critical attitude in which all the lights and intervals seemed the same, although at other times they perceived rhythms. Two other subjects thought that the lights seemed more irregular when they beat time the same way. From their critical nature some subjects at once found it almost impossible to consider an appearance of rhythm as soon as they had convinced themselves the lights were alike. Subject 21, for example, said when counting in twos: "They

are alike as two peas. My conviction is that those lights are just alike and come at perfectly regular intervals. If I were to expect things to be alike and they were as near alike as those lights I should be satisfied. I should think I made up my mind that the lights were alike and afterward believed them alike." The same subject when listening to the beats of a metronome and asked if he could make them seem in groups of two said: "The time, intensity and tones of the beats seem alike even when I beat time. I can't honestly say that there seems any difference in the sounds." Subject 13 was of the critical type who found it practically impossible to assume a passive attitude. His introspections seem to flatly contradict themselves at times, so that I am not convinced he obtained a rhythmic impression from either metronome beats or lights. He said concerning the metronome beats .3 sec. apart: "I naturally group them in fours. I studied music when a child. It was 1, 2, 3, 4 and I have never gotten over it. The interval between does not seem different. I just count four and start again. I think I see what is meant by a rhythmic impression and I do not think I get it. I can sit here and imagine that the sounds or lights appear grouped; but, if I just notice them, they do not." At another time he said that, when he imagined the lights in groups with a longer interval between the groups, they did appear that way while he looked at them.

Movement and Tension Sensations.

Serial flashes of light give an unusual opportunity to study the perception of rhythm in a field where few subjects have experienced it before. We can see the rhythm in its making. For this reason it seemed that valuable suggestions might be gathered touching the general problems of rhythm, especially its genetic development. The effect of movement and strain sensations is one of the most important aspects to be noted. First let us notice the impulse to a motor reaction with lights. It is a frequent observation that sounds in series tend to make us move. With a series of like lights we find the subjects saying:

Subject 7: "The light gives me a sort of swaying sensation, as if I wanted to go with it. My head goes back as the light comes on and forward as it goes out." Subject 14: "I have a sort of contracting feeling which seems to rise with the light, a drawn feeling when it is out." Subject 1: "I seem to find almost a physical response to the lights. I get almost as if I expect something to happen." (Note the connection of the physical reaction and expectation). Subject 8 found that the light stimulated bodily movements more than the metronome beat. He said of the latter when beating at the rate of 184 per minute: "There doesn't seem to be any bodily reaction to amount to anything with this as compared with the lights. The light is exciting, while the sound is not at all. The light makes me move my head and vocal organs, makes me tense all over, especially my head and throat." Subject 18, when beating time: "It seems as if the light makes my hand go. Just as if a fellow whistles a tune, the

light commands." There were numerous other observations of a like nature, but these illustrate sufficiently the tendency to move.

More important to note is the movement or straining of muscles directly associated with grouping. These corroborate, I take it, as much as it is possible for introspections, a kinæsthetic explanation of rhythm, such as I have defended in Part I. That muscle changes cause the illusion of grouping is what the following introspections indicate. It is perhaps their chief value:

Subject 15: "The lights do not seem to make a group unless I breathe or move in time to them, or do something." This subject had been uncertain about a rhythmic impression until be began to beat time. He then said: "In the last four pairs, one seems to be brighter. That is persisting pretty well too. I think I was accenting the first with my movement." Later with a group movement to three lights he said: "They are very decidedly coming in threes. The end of the three seems to chop off a series and the next is decidedly beginning a new series, although the lights seem alike in brightness." (Note that the groups were set off by intervals without accent.) Subject 11: "I do not think I ever get the impression of rhythm if I stop all movements, especially, in my case, with the tongue; nor do I think, if I could hold myself perfectly rigid, I could get rhythm from sounds." Subject 17, when grouping: "I feel as if I was getting into a sort of swinging movement, which becomes a tension if I inhibit it." When making a circular movement include three lights for each revolution of the baton, he said: "The movement requiring the most effort seems to emphasize the light. It then persists longer." Subject 14 first noticed a rhythmic grouping when she was nodding her head to three lights. Almost the first thing noted in beating time to lights is that a forcible movement seems to make the light appear brighter. Subject 10: "The second of the two seems brighter; the movement to that one was more emphatic." Subject 1: "The down beat on which I bring my emphasis seems to accompany the light which is most clearly defined, which is marked plainer on the wall, more intense and larger." Subject 4: "I can make any light seem brighter by emphasizing it, by putting an accent on it." (Question—In what way?) "I strain myself, my breathing, my chest." Subject 22: "I found myself taking a relatively strong inhalation on the accented beats and short exhalations on the others. The breathing was not abdominal, but was done by raising and lowering the chest. There was a slight tendency to raise and lower the whole upper part of the body. The raising always marks the accented beat." Rhythmic changes in the lights which follow quite specific changes in movement are illustrated in the following introspections: Subject 2, making a continuous movement in one direction until two lights had appeared: "I only seem to see one light. The two lights seem to fade into each other." Subject 3: "If I move the baton one way to two flashes and then change, the second flash seems to follow more quickly after the first." Subject 4 did not get a rhythm from beating to each light, but when he made a circular movement for a group, then the light on the downward part of the movement seemed brighter. Subject 7, making an up and down beat to one group: "The up stroke seems longer and the light at the end of it seems far-

ther away than on the down stroke." Subject 9, beating a stroke in a different direction to each of the lights in a three-group, found that the longest interval agreed with the longest movement which came before the first light in the group. Subject 6: "When the lights are coming at about the rate at which I breathe that makes a decided difference. When there is an expiration and taking in of my breath to two lights, that makes a more decided rhythm of two." Subject 10 noted that the first movement seemed to be made with more effort and the third movement was light and easy. This agreed with the intensities of the lights as they appeared. Subject 12, who had previously obtained no rhythmic impression, when he came to make a movement covering a group of lights said: "Oh, they are in little bunches. It seems as if I made one beat and then two closer together and get a sort of rhythm of threes in the lights." Subject 19, making a down beat to one and up beat to the next light: "When a person moves the baton up the second light, coming at that stroke, seems to sort of hang fire. The first goes with a sort of snap and the second slides off. The light seems to follow my beating." Subject 20 obtained only one form of rhythm, even with the metronome. It was a three-group in which he made a down movement of the baton to the first and an up movement to the next two of the group. The two on the up beat then seemed to be 'closer together' with a longer interval before them. Subject 14, making a beat in one direction cover two lights and then changing to the opposite direction, noticed that the change in movement made the interval after the second light seem lengthened.

That the grouping impression was not due to a retinal fatigue is shown by observations of quite real fatigue effects on the part of many of the subjects, when first asked to describe the lights. The introspections prove that this was very different from the rhythmic grouping effect. Here are a few examples of fatigue taken from descriptions of the lights:

Subject 5: "The lights seem to increase four or five to a maximum and then decrease. Sometimes there are two or three bright and then only one." Subject 8: "Sometimes I don't see them as well as others. About every fifteenth it seems to disappear." Subject 12: "At times the flashes are pretty definite in outline, then more diffuse. Now they are quick and small; now growing bigger." Subject 15: "Some flashes appear to be brighter; about every fifth appears brighter." Subject 20: "Some seem to be quick and short. After I counted eight, it seemed as if the next four were quick." Subject 19: "The flashes sometimes seem to get quicker and then go slower."

Appearance of the Group.

When it comes to describing the rhythmic impression as the subjects obtained it from the lights, we find at once two characteristic types, accented and unaccented groups. The simplest perception of the group is with no apparent qualitative change in the lights. The units in the group seem crowded closer together and a longer interval appears before the next group starts. Of

the twenty subjects there were seven who only obtained this type of grouping, or else obtained it most easily, finding it difficult to get the appearance of an intensive difference in the lights. Furthermore, the accented grouping was in every case but one accompanied by an apparent change in the interval between the groups compared with the intervals within the groups. Subject 15 reported an accented rhythm which to him seemed to show no difference in the interval between the groups. If we consider that visual rhythm is practically a new experience, we may say with some assurance that it is most easily developed in the form of an unaccented grouping. This indicates that the unaccented group is genetically the most primitive. It agrees with the observation of Squire, previously cited, that the spondee is the earliest free grouping among school children repeating the syllable 'me.'[1] The tendency to perceive at once an accented unit within the group is, however, very strong. It is increased of course by our associations with music. The accented group appears almost always with either the first or last light seemingly brighter, sharper or otherwise emphatic. The most rhythmical subjects are able with ease to voluntarily change the position of the accent or the rhythmic form of the group. Statements from the subjects themselves give the best idea of how the visual group appears:

Subject 8: "I have a tendency to move my head and expect the first light of the group. If I start to expect it I can make the time before it seem longer. The one accented seems brightest and causes more physical commotion. I seem to be ready and waiting to say it. The other just seems to come along as part of a whole. I don't have to bother about it at all." Subject 7: "I can make the group seem closer together. The accented flash seems to jump up quicker. I can put the accent where I please after a little time, but not right away." Subject 15: "When I think of the lights in bunches of three there seems to be a sort of bracket around them. I don't seem to look at the interval after the three. I get to three and then start in again at one, so that that interval does not appear." Subject 2: "Every third seems shorter. The first seems most bright. Between three and the next group the interval is longest." With a two-group she said: "The first is always stronger than the second." Subject 17: "You can get nearly any rhythm you want. If I take an indifferent attitude, the second light seems brighter. If I start with making the first bright that will continue. Or I can make a difference in the duration of the lights; one will stay longer. Between the groups is a longer interval. The more emphasized light seems to spread out farther and be stronger. I can have my attention on

[1] *Op. cit.*, p. 50.

something else and yet the grouping continues. The two grouping I think may become entirely involuntary with me. There seems to be a rest after each group." Subject 11: "Every other one is brighter, larger, more intense. When I remain quite passive there seems to be a shorter interval between lights one and two, counting in twos." Subject 22: "At first I thought I could make the alternate ones seem longer. Then the one I attempted to accent seemed heavier, rather than longer. I finally concluded that I had a feeling that one of the intervals contained more time, not because it was longer in duration, but because the time hurried along faster. I thus perceived more time in the interval. I tend to see time in strips and thus measure it in special terms. I also noticed that when I perceived a two-rhythm the entire group was perceived as a unit, the interval between the lights forming part of it, so that the duration of the lights themselves had little effect."

The pleasure-pain effects of the light series varied considerably. Subject 7: "At first it was sort of startling. Now it is pleasant, sort of soothing effect. It tends to make me dreamy." Subject 11: "It is pleasurable; rather exhilarating." Subject 7: "It is monotonous." Subject 5: "They don't irritate or tantalize me." Subject 2: "They make me mad, because of the associations with the metronome."

Produced Visual Rhythms.

Early in the introspection of each subject, in order to test how strong the tendency to visual rhythm was, I arranged a plan by which the subjects by pressing slightly on a noiseless key could produce light flashes at intervals to suit themselves. The lights remained on the wall as long as they held the key down. The key was an ordinary telegraph key, made practically silent by limiting its play to a fraction of a millimeter. The lights were produced by connecting the key in the low potential circuit of the relay. Each pressure of the key drew over the armature of the magnet and allowed the high potential current to pass through the incandescent bulb. The subjects were told to produce a series of lights in the way that seemed most agreeable to them. This test was tried before the subjects had tried beating time to the serial lights. Only one person who had not obtained a rhythmic impression from the lights previously, seemed to develop the impression here. He said: "There immediately came into my mind special melodies which I might beat. There was a feeling of curiosity as to how a song you are familiar with would look." I observed that he

was grouping in threes and found that he had been keeping the rhythm of one of the popular waltzes. The experience of producing a light flash by a pressure with the finger was so novel that nearly all of the subjects contented themselves at once with seeing how regularly they could make the lights come and go. Six subjects out of the twenty produced rhythmic groupings of two or three lights. Producing flashes in any way agreeable to the subject I conclude is quite ineffectual in developing a rhythmic impression. If the subjects practiced producing the lights in groups this might aid the feeling of visual rhythm from an objective series of flashes. It seemed to do so with some who tried it.

Later in the experiments, after the subjects had obtained visual rhythms from the serial lights, I had them produce the flashes again, this time with the direction to make groups of two and of three. I then timed ten groups each way. From an average of the twenty subjects tested the groups were found to be the following lengths:

Two-group, 2.0 sec.; Av. error of Av., .1 sec.
Three-group, 2.4 sec.; Av. error of Av., .1 sec.

This close agreement of the lengths of the groups for two- and three-rhythms is in accord with the general opinion as to the rhythms of sound and of movement. The tendency in rhythm is to keep the group length about the same. If the subject had added a proportional time for the extra third light the group would have been 3 sec. long.

Limitations in Grouping.

Two other series of experiments, after the subjects had perceived visual rhythms, have a direct bearing on the nature of the experience. In one series the subjects were asked how many lights they could group when the intervals between were .7 sec. long. This was a fairly convenient rate for visual rhythm, the rate they were most familiar with. In the other series of experiments the rate of the lights was slowed to 1 sec. and the subjects asked if they could still group. If they could the interval was lengthened still more. These experiments indicate the limitations on grouping for flashes such as we

worked with. As to the number of units possible to group when the lights were .7 sec. apart, the subject was asked: "How many lights can you voluntarily keep in a group, holding the rhythmic impression so that you seem to compare one group with the next in return of the same feeling? What, if anything, is there in the rhythmic impression besides counting?" Five subjects were quite certain that three was the largest group which they felt rhythmically; five subjects named four as the limit; five named eight; two named five; one named six, and one named thirteen. Groups above three often broke up into smaller divisions, but the higher group still preserved its unity in the cases I have classified above. All the subjects tried higher groupings and several at times thought they obtained groups above these limits, one even naming forty as the limit. I shall discuss these large groups below. Some of the comments of the subjects show how real was the experience of grouping:

Subject 7: "Up to five I think I set the groups off just by muscular sense, without any counting at all. Above that I think it is only counting. The lights seem to group into threes almost involuntarily." Subject 8: "I don't believe I can group more than four. With eight there seem to be two groups of equal value. What broke it into fours was the fifth light flashing out more brightly. There is a tension mentally and physically before the accented. The others fall without effort." Subject 10: "I would almost swear as to the long interval at the end of the group." Subject 12: "I think I group thirteen but not more. With thirteen there is a certain sense of wholeness. Above that I begin to feel a discontinuity. The group feeling seems to be concerned with expectation, with how big a bunch of things I am going to group. When the group gets too big it begins to split." Subject 16: "With four it is easy enough. The members seem to run closer together in the group. With higher numbers I can get a division between the groups, but can't seem to keep the whole in mind. They are not so cohesive." Subject 17: "In voluntary grouping I have my attention on a kind of strain. I can group with my breath, little hitches in it." Subject 18: "There seems to be a sort of hazy light during the group and then clear between the groups."

One of the most interesting introspections is that of Subject 9, who thought she actually obtained a grouping impression from 40 lights. All groups above four lights broke into smaller groupings with this subject; but she still thought she held the higher group together. It is difficult to suppose that a group over 20 sec. long could be felt as repeating. Here is her introspection of the higher groupings: "I can go to 20. This is not nearly so good as 18 or 16. The last four lights become very disagreeable. I want to drop them." After saying that she grouped 40, I asked if there was more than counting and making a longer interval at the end. "Yes, I was drawing it out. I would represent my feelings

as a rather flat curve. It is like holding a note. It is an effort and unpleasant, but I think I hold them all together." When told to try 60: "There is a muscular sensation from breathing. I lost it a number of times. I had to take a breath and I would not in the smaller numbers. I think I can do 40, but I have to make all the lights in between less brilliant. I don't let them seem as bright. If I hold one breath over the whole 40 it seems more like a group." She held her breath thus to get the 40-group. She tried to get a rhythm by associating a continuous monotone with 60 lights, but said: "The monotone did away with the rhythmic swell. It makes it flat. So long as I can hold my breath I can get a rhythm. I can't hold my breathing for 60." Several other subjects thought at times they obtained rhythmic groups containing from 10 to 20 lights, but their introspections were too uncertain thus to classify their experience.

The facts brought out by the attempt to get long groups are of value. In every case, it is to be observed, the grouping experience seemed to reach limits. In most cases this was very early. Long groups appeared invariably separated by decided intervals. The lengthened intervals were often accompanied by conscious changes in muscular tension, or by movement. The attempt to make large groups caused the subjects to note how they grouped. So far as they were able to describe the process in any but figurative terms, this grouping factor was apparently associated with kinæsthetic sensations.

As to the interval which may elapse between the lights and voluntary grouping still be possible, I found that the majority of the subjects could not group lights 2.5 sec. apart. Three subjects grouped when the lights were 2.5 sec. apart and three when they were 4 sec. apart. One subject, the same who obtained the 40 grouping above, thought she could group when the lights were 7.5 sec. apart; but could not when they were 9 sec. apart. The introspections here, as to the grouping impression, were similar to those when many units were grouped. So far as I could judge on careful questioning the earlier impression of rhythm was absent at the limits I have described.

Similarity to Auditory Rhythm.

A direct comparison of the rhythmic experience obtained from lights with that obtained from sounds was made by each of the subjects. The fact that no subject traced any difference in the essential quality of the experience is the best evidence, it seems to me, that we are dealing with like experiences in the two fields. There are differences in distinctness, in forcible-

ness of the rhythm ; but these are differences of degree, not kind. The rhythm in lights is usually more difficult to experience at first and harder to maintain. A striking fact, already noted under the difference in subjects, is that the two people who obtained only a questionable rhythmic experience from lights had the same difficulty with sounds. All the other 24 subjects were positive in their statement that they did experience a rhythmic grouping in the series of like lights. For the purpose of an introspective comparison the subjects were asked to listen to the sounds of a metronome. This was first run at the rate of 120 beats per minute, about the speed of the lights; and then at the rate of 184 per minute, which is supposed to be very favorable for sound rhythms. When the subjects were asked to describe the rhythmic impression from the sounds as compared with that from the lights, the most suggestive statements were as follows:

Subject 2: "The changes with the metronome are more definite and fixed. With the lights I might believe anything: I feel as if they might seem different next time. However, I find that I can change the accent with the sounds, although I supposed I could not." Subject 3: "There is more rhythm than I get from the lights. There is more emphasis on the first of the group here than with light, although the two within the group come together in light as they do in sound." Subject 8: "So far as the stimulus is concerned the rhythm seems to be more in the sound. In the lights I seem to notice the rhythm more in my reaction. The rhythm is therefore more sharply defined with the sound." Subject 9: "I can change the accent as with the lights. The individual lights are more gradual, the sounds come out with more of a jerk." Subject 10: "The sounds give me a more business-like rhythm. The idea of rhythm comes out more sharply." Subject 11: "In case of sound I am less able to vary and control the rhythm. I am not sure whether this is not due to my being more in the habit of regarding sounds in rhythm and making movements to them. We are more accustomed to an auditory series than a visual. It took some time to adjust myself to an introspection of the lights." Subject 12: "I can keep track of the sound rhythm easier, when I once get it going. There is just the same sort of feeling as with lights in starting a rhythm." Subject 14: "Sounds grouped more easily than the lights and I perceived the accent almost without trying." Subject 16: "I can get rhythmic grouping from the lights, but it does not seem to stay that way. There is more irregularity within the group than with sounds." Subject 17: "The sound is more responsive to changes in tension that I make. If I try to change the accent I have to do it by pressing my tongue against the roof of my mouth, or something like that. I do the same with the lights." Subject 19: "You can make the beats seem to say 'tick tock.' I didn't associate words that way with the lights. With the lights I should not notice the rhythm without its being suggested to me."

Similarity between the visual and auditory rhythmic impressions is one of the main questions of this introspective study. Are they alike, or are visual rhythms intrinsically motor and not, therefore, in the field of sight? We must admit that no light can be seen without an appearance of movement, as I have already noted. Is it these apparent movements that are grouped, or are they secondary and unnecessary to the grouped impression? The fact that only two or three subjects paid any attention to the seeming swell and contraction of the flash in getting their group feeling indicates that it had nothing essential to do with the rhythm. Moreover, the closest observation of the subjects' eyes when they were grouping lights, failed to show any movement of the eyeball. The kinæsthetic reaction on the part of the subject, which I believe accompanies rhythm, was not, therefore, *started* by motor sensations recurring in series. It arose from the series of light sensations in exactly the same way as it seems to arise in the case of a series of sound sensations. Under such conditions I believe we are thoroughly justified in supposing the subjects were right when they said they obtained a rhythm from the lights, and that they used 'rhythm' with the same psychological meaning as when speaking of sounds. Rhythm in any sense order might be said to require a motor factor, but that does not require us to say we have no auditory rhythm. Besides the purely motor rhythm from repeated movements, we realize that the impression may arise from an objective series of stimuli. These may be addressed to the ear or to the eye or probably to the other senses. The rhythm from successive lights is no more motor than is the auditory rhythm, and it is motor in exactly the same sense.

4. Interval and Intensity Illusions in Objective Light Rhythms.

In the following experiments the subjects were shown lights in series but grouped objectively by intensity or interval changes. My chief purpose was to determine, if possible, any general subjective rhythmic attitudes which would be assumed toward such objective changes. For example, when all the intervals were alike, would the subjects uniformly feel that the time

before the bright light which began a rhythmic group was longer? Would the first of uniform lights appear brighter after a long interval which objectively separated the lights into groups? What, if any, main directions could be assigned to these subjective tendencies? These were some of the questions to be answered. The investigation was different in purpose from that which Meumann conducted in the time valuation of intervals bounded by loud and dull sounds.[1] He and others, when working toward an exposition of the time sense, gave their subjects two intervals for comparison. In my case a regular series was kept up until the subject fell into the rhythm, when he was asked to describe the group appearance, both as to intensity and interval differences. Meumann sought to find how time intervals were valued. I sought to find the nature of the group impression as carried over into an objective series.

Objective Intensive Accent.

The objective rhythm with a bright flash every second or third light was given in two different ways. Under the first method (*A* in the tables), the difference in the lights was produced by intercepting a piece of opal glass in front of the box containing the incandescent bulb, thus dulling the flash as it appeared on the wall. The other plan (*B* in the tables), was to use 60° and 40° contacts. This, of course, does not cause an objective difference in intensity of the lights, but has that effect on the subjects. The lights were actually different in duration by about .1 sec., but to the subjects they appeared as different in intensity, the longer always appearing brighter. (See my previous discussion of method.) The difference in the duration of the flashes was unnoticed as such. Under both methods the intervals were kept uniform between the flashes. Under method *A* the intervals were .7 sec. Under method *B* they were .45 sec. when the three-group was given, and .8 sec. when the two-group was given. These intervals were found suitable for easy grouping and introspection. The changes in interval were made for convenience in arranging the 60° and 40° contacts on the contact wheel. So long as a different rate

[1] *Philos. Stud.*, IX., 274 ff.; XII., 128 ff.

did not interfere with the introspections, it was not necessary to maintain the same rate throughout the experiments. The lights from the 60° contacts were .3 sec. long and those from the 40° were .2 sec. The 60° contacts were used also in method *A*. Twenty subjects were tested. They were asked after observing each series to note any apparent difference in the length of the intervals or, in the case of the objectively uniform lights, in the intensity of the lights. They were to group the lights first with the accent at the beginning of the group and then at the end. Any change in appearance, when the accent was thus shifted, was especially to be noted.

Considering first the two-group with one light accented by being apparently brighter, the subjects noting the various differences are tabulated according to their statements. The accented figure (1′, 2) indicates that the bright light was regarded in that position in the group when the subject gave the introspection tabulated below. *A* and *B* refer to the two methods described above for producing the apparent intensive changes.

	1′, 2		1, 2′	
	A	*B*	*A*	*B*
Long before 1,	11	17	10	9
Long before 2,	5	3	3	9
Equal,	3		2	2
No decision,	1		5	

One of two reasons may usually be assigned why an interval seems longer. These arise from two tendencies which have different force according to the individual. Apparently the subject may consider the groups set off by a change in interval (always a long or always a short interval between the groups); or he may always note an appearance of a long interval next to the bright light (either consistently before or consistently after it). This is brought out in the following comparison, which shows the number of individuals who pursued one or the other of these methods when they changed the grouping from 1′, 2 to 1, 2′.

	A	*B*
Long always between the groups,	7	8
Short always between the groups,	1	2
Long always after the bright light,	4	1
Long always before the bright light,	1	7
Intervals equal,	2	2
No decision,	5	

We see that under method *B*, which was most convenient for introspection, ten subjects judged the intervals according to some grouping scheme which continued under both positions of the accent. Eight under method *B* kept the lengthened time in the same position as regards the bright light, either always before or always after it. This would contradict any uniform group arrangement of intervals, such as a long interval always between the groups. Those judgments where the intense stimulus seems to determine the position of the long interval might be explained as due to some condition of the eye connected with the bright light. For example, the effort connected with the decided change in the adaptation of the iris to the bright light might increase the apparent interval. But no such explanation could meet the cases where subjects persist in lengthening the interval between the groups, at one time before and next time after the bright light. It seems best to interpret these cases as due to the rhythmical attitude of the subject. This attitude is bound up, I should say, with muscular strain or movement, voluntarily or involuntarily started. Changes in tension or movement correlate with the interval illusion between the groups.

The same conditions of illusion are followed through for the three-grouping in the following table:

	1′, 2, 3		1, 2, 3′	
	A	*B*	*A*	*B*
Long before 1,	8	14	11	11
Long before 2,	9	3	2	
Long before 3,			2	5
No decision,	3	3	5	4
Shortest before 3,	14	18		
Shortest before 2,	2			
Shortest before 1,	1			
No decision,	3	2		
No. 2 dimmest,	14	14		
No. 3 dimmest,	3	3		
No decision,	3	3		

It will be noticed that two supplementary questions were asked as to the 1′, 2, 3 grouping, viz., the shortest interval and the dimmest of the two like lights. The answers to both indicate very general tendencies. We can say with some assur-

ance that the dimmest light is the one after the bright light. This apparently has a simple physiological explanation in the fatigued condition of the retina after an intense stimulus. The other tendency, *i.e.*, for the interval between the two dim lights to be shortened, is not so easily explained. It appears to be part of a group form in three-rhythms which is very general. It is contrary to general experience for dim lights when not in a group to appear to follow more rapidly than bright. (See note at the end of this section.) This indicates that the appearance of quickness here is connected with a specific rhythmical attitude. We should therefore look for its explanation in the rhythmical muscular responses. Slight muscular responses from the dimmer light flashes might be interpreted as tripping off more rapidly and the effect read over into the series of lights. Easy movements, meaning rapidity to us in other situations, would here associate the idea of rapidity with the dim lights in an objective three-rhythm.

With the three-group we also find the same methods at work in naming the position of the longest interval, as we found with the two-group. This is brought out as the subjects change from the 1′, 2, 3 to the 1, 2, 3′ grouping. It is shown by the following table:

	A	*B*
Long always between the groups,	6	8
Long always before the bright,		5
Long always after the bright,	5	3
Irregular,	4	
No decision,	5	4

Here again, under the best method, *B*, we find 16 out of the 20 subjects pursuing one or the other course I have outlined. The method by which the long interval is always kept between the groups indicates undoubtedly a more rhythmical attitude on the part of the subject. The illusion there may be said to be due to the feeling of rhythm, while the illusion in the case of those who keep the long interval next to the bright light probably has nothing to do with rhythm. As one or the other attitude predominates in the subject, so will his decisions be. The rhythmic attitude is plainly indicated by remarks like the following, which several of the subjects made: "Lights

Nos. 1 and 2 are always nearer together, whether the first or second is brighter." The two tendencies may combine at times and then a more pronounced interval appears. This is shown by a remark of Subject 6 when the 1, 2, 3′ group was tried: "The long interval is now *decidedly* after the bright light." With the 1′, 2, 3 grouping he had been uncertain, but when he changed the accented light the tendency to lengthen after the bright light, as well as to lengthen between groups, came together. He then noted emphatically the appearance of a long interval.

A rough measurement of the illusion in the case of the rhythmic attitude gives some idea of its strength. The ability to make a dimmer light seem brighter by accent in a group was tested by a method similar to *B*, in which the apparent dimness resulted from shortening the light. The test was made by revolving a disk, containing openings, in front of an electric lantern. The four rhythmical subjects who were tried found that, when merely trying to judge the lights, they could distinguish eight out of ten times a difference of .06 sec. in the lights .35 sec. long. The difference appeared as a difference in brightness, the long light always seeming brighter. Giving these subjects a rhythm with intervals between the lights about .7 sec. long and equal, they were all able to carry over an objective difference of .12 sec. in the duration of the lights, *i. e.*, they were able to make the shorter light seem brighter. To test the illusion of interval and see what difference could be carried over and the short interval still seem longer, I changed the position of the 40° contact, method *B*, in the experiment with the two-group. I found, with four subjects tested, that a difference of .15 sec. could be made between the intervals when the lights were about .7 sec. apart, without the subjects noting any effect on their rhythmic grouping. They all considered the interval before the 'bright' light (60°) longer when it began the group, although it was actually .15 sec. shorter. This objective difference could easily be distinguished by observation, but had not interfered with the opposite interval appearance between the rhythmic groups.

The illusions due to rhythmic grouping in lights are apparently the same as those that have been noticed by other observ-

ers for sounds. They include the lengthening of the interval between groups, the intensive accent, and the shortening of the time between unaccented units in the three-group. MacDougall, for example, pays especial attention to the lengthening of the group interval when listening to objective rhythms of loud and dull sounds.[1] Bolton notes the same thing in subjective grouping of sounds.[2] Squire shows the intensity and duration relations in speaking rhythms to be similar to those noted. She finds the end of the group marked by the longer pause.[3] Similar effects of rhythm on intensity and pauses are found in tapping rhythms or beating them on a drum.[4]

The rhythmical attitude toward the light series I have attempted to distinguish from that attitude which tends to place the long interval always next to the bright light. This latter attitude I have regarded as non-rhythmical under the supposition that it might be due to some peripheral change. To further test this hypothesis I tried the following experiment. A bright flash was brought into a series of uniform dull lights at an unexpected time. The intervals between the lights were .7 sec. as before. The subjects were told to notice any difference in the appearance of the interval or the light that followed the bright flash. The bright flash was produced by removing the opal glass from in front of the incandescent bulb. The introspections of 17 subjects as to the units after the bright light were as follows:

Next Interval.		Next Light.	
Longer,	12	Dimmer,	14
Shorter,	3	Brighter,	2
Alike,	2	Alike,	1

This strong tendency to lengthen the interval after the intense stimulus agrees with the observation of Meumann, who tried a similar experiment with a sound series. He introduced a loud hammer stroke into a series of dull strokes. Meumann suggested that the reason why the interval after the loud sound

[1] 'Harvard Psychol. Stud., I.,' *Monog. Sup. Psychol. Rev.*, IV., 378, 381.

[2] *Amer. J. of Psychol.*, VI., 204.

[3] *Op. cit.*, p. 52.

[4] MacDougall, *op. cit.*, p. 362. Miyake, *Stud. from the Yale Psychol. Lab.*, X., 15 ff.

was lengthened was because it began a new measure after a pause.[1] MacDougall found an opposite result in his experiments with a sound series. He says that "The influence of the introduction of such a louder sound is to cause a decrease in the apparent duration of the interval which follows it, and an increase in that of the interval which precedes it."[2] There can be no doubt that for the series of lights as used in my experiments the tendency was strongly, as Meumann found it, to lengthen the interval after the intense unit. The discrepancy with MacDougall's results with sounds may have been due to the difference in the quality of the stimulus or the length of the intervals. The explanation given by Meumann for this illusion in the interval does not seem sufficient. The lengthening could not be due, as he suggested, to a rhythmical attitude. A grouping would hardly be brought out suddenly by the introduction of a single bright light. If it were, the group would naturally begin with the bright light; not with the next light, as he thought. The fact that about a quarter of my subjects held to this tendency to lengthen the interval after the intense unit, in spite of the rhythmic tendency to lengthen the interval before the group, when the arrangement was 1′, 2 or 1′, 2, 3, indicates that the result may be due to some physiological condition in the sense organ, preceding any rhythmical reaction. Whether this condition is an adaptation of the pupil of the eye, as I have suggested, or some other peripheral change, my experiments would not determine. The point I wish to emphasize is that we have two distinct phenomena, one of which seems to require a rhythmical explanation and the other not. The dimming of the first unit after a more intense stimulus, which is shown in the table above and in that for the 1′, 2, 3 group, suggests a peripheral explanation at once, rather than a rhythmical. It may be explained very simply as the result of retinal fatigue from the intense stimulus. It seems likely, therefore, that with subjects to whom the interval after a bright light is always lengthened and the next light dimmer, the effect is not due

[1] *Philos. Stud.*, IX., 276.

[2] 'Harvard Psychol. Stud., I.,' *Monog. Sup. Psychol. Rev.*, IV., 364.

primarily to any rhythmical grouping, but to a peripheral change.[1]

Objective Interval Grouping.

When uniform lights in a series are set off into groups by a long interval after every second or after every third light, we have a different kind of objective rhythm in which to test the effect of subjective grouping. In these experiments the lights were .3 sec. in duration and separated by intervals of .7 sec. The groups were separated by a double interval. Here we find a great variety of rhythmic and judgment attitudes assumed by the subjects. They differ so much that classification almost becomes enumeration. The subjects were asked to describe any apparent difference in the lights within the objective groups. I have attempted to arrange the introspections in tabular form. The table ought not, however, to be interpreted as emphatically as tabulation makes it seem. In many cases the subjects were quite uncertain in their observations. The apparent difference in the lights was comparatively slight. The main result of the experiment was to demonstrate the great variability in attitudes. The number of subjects is given whose introspection was approximately in the form stated.

	2-Group.	3-Group.
Any light brighter, depending on how I accent,	6	4
None brighter, or not sure, even when accented,	2	2
First brighter naturally, without seeming to accent,	6	2
First dimmer naturally, without seeming to accent any,	0	3
Last brighter naturally, without seeming to accent,	2	2
Only the first would seem brighter when I accented,	1	0
Only the last would seem brighter when I accented,	3	6*
Only the middle would seem brighter when I accented,	0	1

* With three of these the last always seemed brighter even when they thought they accented the first. With the others the lights all appeared alike if they accented other than the third.

[1] Comparing a series of bright lights with a series of dull at the same rate, the dull produced by intercepting the opal glass, I found the tendency was for the brighter series to appear faster. Meumann obtained the same result with a few subjects when comparing series of greater and less intense induction sparks produced inside a sound-proof glass case. He also found that a louder sound series appeared faster. (*Philos. Stud.*, IX., 274 ff.) My results indicate that the illusion is not so decisive as he implies. Of the twenty subjects I tested, nine thought that the bright series was faster, three that the dim series was faster, and eight noted no difference. Meumann explains the effect as due to

The divisions in the above table are not all mutually exclusive. Some of those who found one light naturally bright could make others appear brighter by trying. I have tried to place such subjects according to the emphasis of their introspection. Supposing that all who naturally found the accent in one place could change it, we have from thirteen to sixteen who would say that the apparent differences in brightness were largely controlled by them. The striking thing is, perhaps, that there should be seven with the three-group and four with the two-group who found this rhythmic difference in brightness apparently beyond their control. In these cases the tendency was nine out of eleven to brighten the last light in the group. This could hardly be a retinal effect, at least nothing like fatigue, for the long objective pause came before the first light in the group which should then appear brighter. It apparently must be due to some central association or reaction after the light stimulus reaches the brain. This again might be a varying muscular response. It seems safe to say that nearly all the apparent changes in brightness which appear when like lights are set off into groups by long intervals, are due to some rhythmical attitude; but that these attitudes vary decidedly among different individuals.

5. Summary.

Contrary to the prevailing impression, we have found that the experience of rhythm in the field of vision is identical in its essentials with that in the auditory field. Since the experience is novel, it is at first more vague than with sounds, but it becomes quite precise with practice. Although visual rhythm is less distinct, it is just as direct as auditory. The difference, so far as is noted, is in degree, not in quality. The experiments show rhythm to be subjectively experienced from a series of like lights. Twenty-six subjects found this to be true in some measure. Whether the group feeling may arise involuntarily

fusion, the more discontinuous series appearing slower. We might suppose the effect explained peripherally by the brighter lights causing more commotion in the retina and leaving shorter rest periods; or the effect might be explained centrally as the interpreting of a bright series to be more rapid on account of the individual lights seeming to swell out more suddenly.

is not certain, but the introspections of two subjects at least indicate that it may. Both auditory and visual rhythm seem to be illusions due to the muscular reaction of the subject, combined with the sensations from objective serial stimuli. Rhythms in sight furnish new evidence of this connection between the experience and muscular tensions and movements. Subjects are better able to introspect here as to the bodily correlate, because not habitually neglecting it as with sound rhythms. Their observations show that apparent changes in the lights correlate with differences in movement. The difference between subjects as to their inclination toward rhythmical perception is more pronounced than in the practiced field of sound. Visual rhythms show several marks of being real experiences rather than ideational creations. Among these may be mentioned the fact that grouping has somewhat narrow limits and tends to rather definite forms. Voluntary grouping ordinarily stops before the lights are 2.5 sec. apart. Nearly all the subjects find it extremely difficult to hold more than four lights together in a group. When produced by the subjects, a group of three lights tends to the same length as a group of two. For the apparatus used this group length was about 2 sec. Favorable rates for grouping were found to be .5 and .7 sec.

The rhythmic experience in vision is fruitful for study, not only because it allows us to trace the varying forms and accompaniments to better advantage than in conventional sound rhythms, but also because sight rhythms are very suggestive in a genetic investigation. They show how the experience may be gradually developed by accompanying movements. In this development we find groups at first frequently perceived without accent, *i. e.*, set off solely by longer intervals. This may be regarded as a more primitive stage of the perception, a stage which some subjects find it difficult to pass beyond. The accented group, however, is most commonly experienced in subjective rhythmization. In this form the origin of the accent can usually be clearly traced to kinæsthetic changes.

The attitudes of the subjects toward objective rhythms indicate that apparent variations in intensity or interval may be due to either peripheral changes or rhythmic reactions. The length-

ening of the interval after an intense stimulus and the dulling of the next sensation are apparently of the peripheral order. An accentual brightness within the group, the lengthening of the interval between groups, and the shortening of the interval between the second and third units in a 1′, 2, 3 rhythm, are probably connected with the rhythmic response. These latter tendencies as to the form of the group are similar to those found in the field of sound.

PART III. MOTOR EXPRESSION OF TIME INTERVALS.

Rhythms and time are so intimately interwoven that I may be allowed to present here two series of experiments which bear upon the motor side of time problems. The first series studies the effect on the reproduction of time intervals when the standard is bounded by unlike stimuli, a sound and a light, compared with a standard bounded by like stimuli. The second series deals with the continued reproduction of the same interval and the correlation of the constant error of the individuals with their reaction time.

1. Intervals Bounded by Unlike Stimuli.

The problem in mind in studying intervals bounded by different stimuli was to determine whether the memory of intervals of medium length was dependent mainly upon the sense organ to which the interval was given, or to some adjustment, very probably motor, which took place after the stimulus reached the brain. The intervals from 2 to 6 sec. were found to be reproduced as accurately when the standard was bounded by lights as when bounded by sounds. For intervals above one second the eye seemed to be about as good a sense organ for perceiving time as the ear. As distinguished from this there was a decided break as soon as the interval was bounded by one light and one sound. While it is not impossible to suppose that this break was due to greater difficulty in perceiving the stimuli when coming to different organs in succession, such a view does not seem to me to be likely. We can turn our attention, at this length of interval, with comparative ease from a sound to a light, but if we attempt to make a movement first to a sound and then to a light we find the effort considerable. If, now, we were to suppose that the memory of the time interval depended upon the muscular adjustment which followed the stimuli, we would have a fitting explanation of the break which

occurs in remembering and reproducing an interval bounded by two unlike stimuli, as compared with the same interval bounded by like stimuli. This result, therefore, seems to have a bearing upon any theory of the time sense which places the emphasis on a muscular adjustment rather than upon the fading of the sensations or the perception of a monotone of bodily feeling during the interval. Münsterberg has developed the theory that we try to reproduce the same feeling of strain in judging time intervals. He pays especial attention to judging by respiratory rhythms for longer intervals.[1] Horwicz has suggested that movements of various parts of the body are used for time judgments.[2] Wundt emphasizes the limb movements.[3] Meumann found that the bounding stimuli might be changed in intensity without materially affecting the memory of intervals which were over half a second long. He concludes that for intervals longer than this the sensations are of comparatively small importance.[4] My experiments were conducted with intervals 1, 2, 3, 4 and 6 sec. long. They indicate that there is a difference in constant error between the light interval and the sound interval for 1 sec. but not for 2 sec. or above. Moreover, they show that even for 1 sec. there is a decided break between the interval bounded by like and by unlike stimuli.

Method of Experiment.

In my experiments I arranged as far as possible to avoid both practice and contrast effects. Five subjects were tested. Each of the intervals was reproduced twenty times in each of the forms of stimulus in which it was presented. The same interval was never given twice in succession nor was any regular progression followed. The order was determined by a chance arrangement which was not repeated until the subject had made a total of twenty-five reproductions, so that the reactor was always ignorant of what interval was to be presented next. To further avoid practice and fatigue, reproductions were made for only an hour at each sitting. I wish to lay stress on the advantage of the

[1] Beiträge, 1889, Heft 2, p. 1 ff.

[2] 'Psychologische Analysen auf physiologischer Grundlage,' Band II., Heft 3.

[3] 'Outlines of Psychol.,' Judd trans., p. 159.

[4] *Philos. Stud.*, XII., 129.

subject not knowing what interval he is to reproduce. From a test made with one subject in reproducing the same interval in succession, I found a correlation of .63 with a standard error of .03 between the way he reproduced the interval one time and the next. This shows a strong tendency for over- or underestimation in one judgment to affect the next judgment of the same interval if that is immediately repeated. The effect of such a large correlation must be considerable in all investigations where the subject continuously judges the same interval. Under a chance arrangement of the intervals this effect of the previous reproduction should eliminate itself. I found no effect of practice between the earlier and later judgments under this varied arrangement. Not only were the intervals given in a chance order, but after five reproductions had taken place with each of the sound intervals, the series was changed to lights, then light-sound and sound-light intervals in a double fatigue order, so that all the different forms of the standard would have any advantage there might be from practice with the others. Sound intervals could thus be compared with any of the other series. By these methods I am confident that more correct information as to time judgments was obtained from averages with a small number of reproductions than could have been acquired with hundreds of reproductions otherwise.

For a sound stimulus I used the click of a telegraph sounder. For a light stimulus I used a streak of bright light, 50 by 4 cm., thrown by an electric lantern on a screen. A cardboard disk, 40 cm. in diameter, revolved in front of the lantern, allowing the light to pass through a radial slit in it, 2 mm. wide, when this came in line with a narrow slit in the focus of the lantern. The disk contained two such openings 180° apart. It was revolved by a heavy iron color wheel connected to a motor through a speed reducer. The error of rotation was exceedingly small and entirely negligible for the length of interval used. Attached to the center of the disk was a small wheel, 5 cm. in diameter and 1 cm. thick, arranged to make an electric contact every time the openings in the disk came in line with the light of the lantern to produce a flash. The contact was made through two light flat springs which rested continuously against the rim

of the small wheel. The current passed between the springs when they touched two brass contacts, connected by a wire and set into the circumference of the wheel 180° apart. This electric current passed through the sounder, while a switch in the circuit allowed the operator to bring in or shut out the sounder as he chose. Between the disk and the cloth on which the flashes were thrown was placed a screen containing a mechanical shutter covering an opening 15 cm. square. This screen cut off the light from the observer's screen until the shutter was opened by the operator moving a lever. The disk on the color wheel was revolved continuously. By means of the switch and shutter the operator could give either a sound or light stimulus to the observer every second or multiple of a second. The subject was placed in a room adjoining that containing the apparatus. The sounder was on a table beside him and the lights appeared on a cloth screen above the table in a window between the two rooms. Within a convenient time after receiving the interval the subject reproduced it by two pressures on a telegraph key. His reproduction was registered on a continuous-roll kymograph. The record was traced in ink by a glass capillary pen attached to an electric marker. The record line was paralleled by an ink line showing seconds. By allowing about 30 mm. space on the paper to each second, the reproductions could be measured with sufficient accuracy. The tables show that the average variability of the subjects in reproducing an interval of 1 sec. was about .2 sec. The average error of the producing and recording apparatus combined was less than .01 sec., which is well outside of the range that would disturb the results. As the subject could not see the apparatus, there was nothing to distract his attention from the time judgment unless it was the whir of the motor. This was very much reduced by mounting the motor on a thick layer of felt. Moreover, it was a constant sound which would not disturb the result for the comparison desired.

The results of the investigation for the five subjects tested are given in the table below. The average for each individual for each arrangement of stimuli is from twenty trials. The average of each group of five individuals is thus for 100 repro-

ductions. The averages are given with their average variability. The error of the individual averages may be determined in the usual way by dividing by the square root of the number of trials.

Subjects.	1 Sec.		2 Sec.		3 Sec.		4 Sec.		6 Sec.		
	Av.	Av. V.	Av.	Av. V.	Av.	Av. V.	Av.	Av. V.	Av.	Av. V.	
A	1.09	.12	2.07	.24	3.03	.29	3.91	.44	5.76	.50	Sounds.
B	.74	.13	2.23	.52	2.85	.73	4.47	.95	5.78	1.16	
C	1.01	.17	1.64	.28	2.27	.46	2.78	.45	3.66	.42	
D	1.07	.23	2.34	.55	3.18	.61	3.78	.54	5.41	.65	
E	1.12	.28	2.15	.33	2.85	.34	3.51	.58	4.59	.76	
	1.01	.10	*2.09*	.18	*2.84*	.26	*3.69*	.43	*5.04*	.73	
A	1.16	.11	1.90	.32	2.90	.29	3.74	.35	5.64	.56	Lights.
B	1.18	.23	2.21	.75	4.10	1.30	4.76	1.33	6.71	1.56	
C	1.00	.25	1.70	.35	2.21	.40	2.55	.49	3.68	.71	
D	1.63	.57	2.58	.52	3.09	.44	3.87	.83	5.04	.79	
E	1.79	.66	2.17	.47	2.94	.58	3.56	.57	4.50	.64	
	1.35	.29	*2.11*	.25	*3.05*	.44	*3.70*	.51	*5.11*	.85	
A	1.27	.17	2.83	.97	3.23	.73	4.46	1.09	6.12	1.00	Sound-Light.
B	2.25	.85	3.31	.93	4.51	1.21	4.99	1.28	6.74	1.18	
C	1.49	.50	2.05	.33	2.21	.45	3.11	.45	3.68	.90	
D	1.48	.37	3.03	.62	3.02	.52	3.74	.62	5.06	.65	
E	1.59	.49	2.47	.61	3.15	.45	3.89	.44	5.33	.59	
	1.62	.20	*2.74*	.38	*3.22*	.51	*4.04*	.55	*5.39*	.83	
A	1.28	.28	2.49	.50	3.36	1.07	5.28	1.02	7.11	1.35	Light-Sound.
B	1.68	.49	3.65	1.21	4.51	.88	5.84	.93	7.45	1.42	
C	1.47	.48	2.22	.47	2.73	.61	3.02	.44	4.10	.93	
D	1.73	.37	2.71	.58	3.12	.53	4.09	.63	5.25	.60	
E	2.13	.78	2.54	.48	3.18	.49	4.07	.52	5.63	.77	
	1.66	.23	*2.72*	.35	*3.38*	.43	*4.46*	.88	*5.91*	1.03	

An examination of the table will show that, with the exception of the 1 sec. interval, the average reproduction was almost the same for lights and sounds. A sharp break, however, occurs in the averages between the intervals bounded by like and by unlike stimuli. I have plotted this difference in the accompanying figure. The averages maintain a difference of almost half a second from each other through all the intervals. The reproduction of the intervals bounded by a light and sound is consistently lengthened. A study of the differences with their variability, in connection with a table of probabilities, will show that we can say the chances are nine out of ten that the 1 sec. interval will be lengthened at least .3 sec. when it is

bounded by unlike stimuli, over the length when bounded by like stimuli. There is a like chance that the 2 sec. interval will be lengthened at least .4 sec. On account of the greater error of the averages for longer intervals, we cannot say more than that the chances remain high, .90 or above, that the average reproduction of intervals bounded by unlike stimuli will be longer.

The averages indicate that the intervals of 4 and 6 sec. given by a sound followed by a light are somewhat less difficult

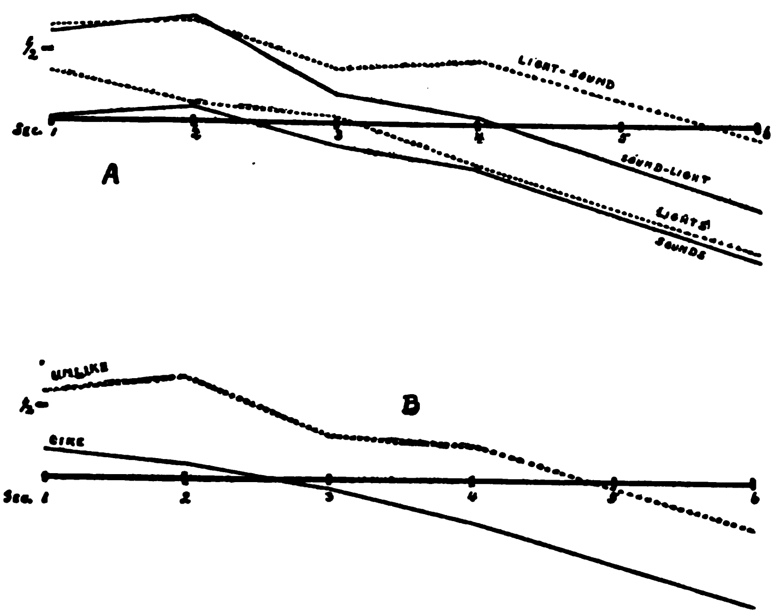

FIG. 6. (*A*) Averages plotted for the reproduction of intervals bounded in various ways. (*B*) Averages for intervals bounded by like stimuli, two sounds or two lights; compared with those bounded by unlike stimuli, sound-light or light-sound.

to follow than when given by a light followed by a sound. It is possible that this may have some bearing on the controversy as to which arrangement of these unlike stimuli is easiest to perceive. Exner found that a light-sound interval of .016 sec. could be distinguished, while a sound-light interval must have the stimuli separated by .06 sec.[1] This has been disputed by Bloch, Tracy and Hamlin. Whipple has recently reviewed

[1] Cited by Wundt, 'Physiol. Psychol.,' 4te Aufl., II., 392.

the subject and made extended experiments under careful conditions. He concludes that the sound-light arrangement for very short intervals is more easily perceived.[1]

Variability.

A study of the variability of the subject in reproducing the intervals in the different forms develops two interesting facts. (1) The subject is somewhat more variable in his work with light intervals than with sounds. This brings out a difference between adjustment to auditory and visual stimuli which was not apparent in the constant error for intervals above 1 sec. A table of averages of the individual average variabilities for sounds and lights is given below. The average error of each average is given after it.

	1 sec.		2 sec.		3 sec.		4 sec.		6 sec.	
	Av.	Av. E.	Av.	Av. E.	Av.	Av. E.	Av.	Av. E.	Av.	Av. E.
Sounds,	.19	.02	.38	.07	.49	.07	.59	.07	.70	.10
Lights,	.36	.10	.48	.06	.60	.14	.71	.09	.85	.14

(2) The increase in the variability with the larger intervals shows a remarkable tendency to follow the law suggested by Cattell and Fullerton.[2] This law supposes that the variability will increase in proportion to the square root of the magnitude dealt with, instead of an increase proportional to the magnitude as suggested by Weber. Nichols gives a tabular review of early investigations on time in which he shows Glass, Ejner, L. T. Stevens as holding that the increase in variability approximately follows Weber's law, while Mach, Vierordt, Kollert and Estel decide it does not hold.[3] Nichols[4] himself decides against Weber's law, as do Shaw and Wrinch[5] and H. C. Stevens more recently.[6] The following table gives the relation of variability for the different intervals as it would occur according to the suggestion of Cattell and Fullerton and as it was actually found for the averages of the individual variabilities in my

[1] 'On Nearly Simultaneous Clicks and Flashes,' *Amer. J. of Psychol.*, X., 280.

[2] 'On the Perception of Small Differences,' *University of Pennsylvania, Philos. Series*, No. 2, 1892, p. 23.

[3] *Amer. J. of Psychol.*, III., 519.

[4] *Op. cit.*, p. 529.

[5] *University of Toronto Stud., Psychol. Series*, No. 2.

[6] *Amer. J. of Psychol.*, XIII., 23.

work. For convenience of comparison the relation is expressed in terms of the variability for 1 sec., taken as a standard.

Intervals in seconds,	1	2	3	4	6
Cattell-Fullerton Law,	1	1.4	1.7	2.0	2.45
Average for all forms,	1	1.4	1.6	1.8	2.3
Average for light intervals,	1	1.4	1.7	2.0	2.37
Average for sound intervals,	1	2.0	2.5	3.0	3.6

Indifference Points.

The question of indifference points in the estimation of time intervals has for years interested investigators. My own results in this connection have their main value in showing how a slight change in method may produce significant changes in the result. This is important in interpreting the meaning of any node of exact judgment that may be found. Estel contended that there is a normal interval of .75 sec. which, with its multiples, is most accurately judged.[1] Wundt suggested that this about agrees with the period of the leg swing in walking. Should this conception be retained, or should we hold that the node varies so much with the method of experimentation that we cannot believe it depends on a general interval most favorable for judgment ? How far are we entitled to say that time estimates depend upon a normal interval habitual to the mind, when we find that different investigators have found different norms; that even where very similar methods have been used different indifference points have been demonstrated; that these are in one place for sound intervals, another place for lights, etc.; that they vary widely with different individuals and even with the same individual; that the same interval is at one time overestimated and at another time underestimated with a certainty that would not be overthrown by chance ? Under such conditions, if they exist, we should be very careful about supposing time judgments to be dependent upon any specific bodily rhythm.

That the average reproduction of a time interval varies a significant amount under very similar conditions maintained by different investigators is shown by a comparison of Seashore's[2] results and my own. We both used intervals of one and two

[1] *Philos. Stud.*, II., 37.

[2] *University of Iowa Studies in Psychol.*, II., 74.

seconds, and judgments were made by the method of single reproduction with two taps on a key. His procedure seems to have been almost identical with mine for sound intervals except in two particulars. He gave his subjects the intervals for judgment in a 'double fatigue' order, while I gave them in a chance order to eliminate progression effects. He told his subjects not to use any aids in remembering the intervals, while I preferred to leave mine uninstructed on this point. In presenting the results for comparison I have averaged his records for men and women together, as they do not seem to show a significant difference for these intervals. I give the average constant error in the reproductions and the average error of these averages. Seashore tested 46 individuals and I only five, so that my averages are more inaccurate.

	Seashore.		Miner.			
Interval.	Av.	E.	Av.	E.	Difference.	Av. V.
1 second,	—.09	.005	+.01	.05	.1	.05
2 seconds,	—.112	.02	+.09	.09	.51	.09

For the 2 sec. interval the chances are thus even that there is a difference between these averages amounting to $.51 \pm .09$ sec. The error of my average for the 1 sec. interval is comparatively large, but we can still say that there is a difference between Seashore's results and my own amounting to $.1 \pm .05$ sec. with a probability of about one to one. Even when two observers use the single reproduction method in as nearly the same form as Seashore and I did, we see that the estimate of a 2 sec. interval shifts on an average about half a second. This of course means quite a change in the position of the indifference point. It is difficult to suppose that the judgment of time depends upon any absolute norm when so slight a change in conditions causes the estimate of an interval of 2 sec. to change a quarter of the magnitude judged.

My results also give an opportunity to compare the records of the same subject under two investigators. One of H. C. Stevens' subjects also acted for me. The records of this subject are different enough, so that we can say with a large probability that in this case a difference in method and not a difference in subjects produced new results. Stevens' method dif-

fered from my own in that he gave the same interval repeatedly to the subject and also in that he required the subject to make only one pressure on a key as soon as the same interval had passed after hearing the standard. In my work two pressures were made bounding the interval. Unfortunately we did not use exactly the same intervals. For the purpose of this comparison we may suppose that the change in time estimation was gradual between intervals of .9 and 1.3 sec., which Stevens used. By interpolating a value for 1 sec. to compare with my record and a value for 2.4 sec. between my 2 and 3 sec. intervals to compare with Stevens' record for 2.4 sec. we get some idea of how the results compare.[1] I have done this in the following table showing the record of the same subject under the two methods. The average constant error in estimation and the average errors of these averages are given:

Interval.	Av.	E.	Av.	E.	Difference.	Av. V.
1 second.	— .05	.005	+ .09	.025	.14	.025
2.4 "	— .117	.014	+ .05	.06	.167	.06
4 " *	+ .02	.07	— .09	.10	.11	.12
6 " *	+ .16	.42	— .24	.11	.40	.42

* Stevens' intervals were 3.75 sec. and 5.45 sec.

This table means that the chances are even that there is a difference between Stevens' results and mine for the same subject amounting to .14 ± .025 sec. in the average estimate of an interval of 1 sec., and of .167 ± .06 sec. for an interval of 2.4 sec. The errors are too great in the averages for the longer intervals for any conclusion to be drawn. Stevens states that he found that the indifference point was lowered from the average position of .72 sec. to .40 sec. when he changed the method of reproduction to one pressure on the key instead of two. It will be noticed that the difference between Stevens' results and my own for either 1 or 2.4 sec. intervals is sufficient to change the sign of the estimate as shown in the averages. Method thus makes the same subject change from over- to underestimating the same interval. This change in method, moreover, is quite slight compared with the change between the method of average error determined by reproduction and the method of judging the least perceptible difference when listening to sound intervals, which was used by early investigators.

[1] *Amer. J. of Psychol.*, XIII., 20.

My investigation of the multiple reproduction of an interval of 1 sec., which I shall present later, also shows a difference from the result of similar work done by Nichols and L. T. Stevens. My results with 145 subjects show that this interval, when reproduced continuously for about a minute, was underestimated on the average about .08 sec. The average error of this reduction is less than .01 sec. Nichols, on the other hand, with 15 subjects found that an interval of 1.25 sec. reproduced for about two minutes was overestimated on the average .05 sec.[1] From his tables I have calculated the average error of this overestimation to be .015 sec. Stevens found intervals between .87 sec. and 1.5 sec. overestimated, when reproduced for about one minute continuously.[2] As he gives no variations for his averages, comparison would be uncertain. It is not likely that the difference between Nichols' results and mine is due to the fact that his subjects continued their reproductions for two minutes, while mine only reproduced continuously for about one minute. I found that forty of my subjects who continued the reproduction for two and a half minutes showed still greater underestimation. This disparity in results seems to be another instance where conditions surrounding the experiment make a significant difference in time estimation under very similar methods. It seems to be further evidence that overestimation and underestimation are not closely dependent upon a comparison with a norm carried in the mind.

A study of the different investigations of time intervals that have heretofore been conducted brings out even more forcibly the danger in supposing there is quite a definite indifference point in time estimation. It is not necessary to go extensively into the literature of the subject. Nichols has done that for all except one or two of the recent investigations.[3] The table which he gives shows how various have been the indifference points selected, as well as the striking differences in the estimation of the same interval under different methods and observers.[4]

[1] *Amer. J. of Psychol.*, IV., 80.

[2] *Mind*, XI., 395.

[3] *Amer. J. of Psychol.*, III., 503-529. See also Wundt, 'Physiol. Psychol.,' II., 408; James, 'Principles of Psychol.' I., 616.

[4] *Amer. J. of Psychol.*, III., 528.

A few instances taken from his table bring out the point. Höring, using the method of right and wrong cases and judging without reproduction, placed the average indifference point for ten subjects between .365 and .454 sec.[1] Vierordt, also using the method of right and wrong cases, but having the subject reproduce the interval by two taps, found that for himself the indifference point was between 3 and 3.5 sec. and for two other subjects about 1.5 sec.[2] Kollert, using the method of least perceptible difference in judging the intervals given by two metronomes, assigned .755 as the indifference point, averaged from seven subjects.[3] This last indifference point has been somewhat corroborated by other observers. Mehner made a series of trials on himself, following substantially Kollert's method, and found a node at about .7 sec.[4] Glass, testing only himself, by the method of average error with a single reproduction each time after the standard, found one node at .7 sec.[5] L. T. Stevens, using multiple reproduction, also found a node there on the average of seven subjects.[6] Recently H. C. Stevens, with a single reproduction of the interval, places the indifference point about the same place.[7] The evidence at first seems to be quite convincing as to a node between .7 and .8 sec. It is to be remembered, however, that Mehner and Glass experimented only on themselves, and their conclusions are not sufficient for generalization. Nichols believes that Kollert's results are not reliable, since he rejected 42 cases as anomalies out of 175 trials.[8] Strong evidence as to the uncertainty of the process of time judgment seems to be furnished by the absolute contradiction among the above investigators as to the direction of the constant error immediately above and below this node of .7 sec., even when they agree as to the node. Kollert finds the intervals above (.755 to 1.836 sec.) underestimated. Mehner

[1] 'Versuche über das Unterscheidungsvermögen des Hörsinnes für die Zeitgrössen,' 1868, cited by Nichols.

[2] 'Der Zeitsinn,' 1868, cited by Nichols.

[3] *Philos. Stud.*, I., 88.

[4] *Philos. Stud.*, II., 546.

[5] *Philos. Stud.*, IV., 423.

[6] *Mind*, XI., 393.

[7] *Amer. J. of Psychol.*, XIII., 1.

[8] *Amer. J. of Psychol.*, III., 509.

finds the same for intervals from .71 to 5 sec. H. C. Stevens shows intervals from .72 to 2.4 sec. underestimated. Glass finds intervals underestimated in one set of experiments from .7 to 15 sec. and in a second set finds overestimation from .7 to 1.8 sec. L. T. Stevens and Nichols find overestimation immediately above .7 second. Nichols' suggestion that multiple reproduction will account for this difference will hardly hold, since Glass, using a single reproduction, found the results one time one way and the next time opposite, and my results with multiple reproduction show a decided underestimation of the 1 sec. interval.

In conclusion, it may be said that there is some evidence of an indifference point at about .7 sec. This evidence, however, seems inconclusive and is rendered less important by the flat contradiction as to the direction of the constant error above and below the node. At most it seems necessary to say that the node will be at that point only under a definite method of experiment. It seems probable that there are numerous indifference points, depending upon the conditions for the time judgment. These conditions are quite as important as any physiological norm in determining whether a certain interval will be under- or overestimated.

2. Multiple Reproduction of an Interval.

The problems of time have heretofore been investigated with either one subject or a few individuals. The material gathered in connection with the psychological tests at Columbia University gave me the opportunity to study a group of 145 students who had been tested for the multiple reproduction of an interval of 1 sec. With this large group it was possible to eliminate the individual differences and determine with accuracy what the effect is of a continuous duplication of the same interval for a period of forty seconds. The result has a bearing upon any study of time in which the method of multiple reproduction is compared with single reproductions. It is demonstrated with practical certainty that the speed of reproduction increases during a half minute of continuous repetition of the interval. This indicates that the averages presented for mul-

tiple reproduction, at least for a one-second interval, will be smaller than for a single reproduction. Allowance must therefore be made for this difference in any comparison of work on time.

The experiment consisted in having the subject tap on a telegraph key ten times in conjunction with the click of a telegraph sounder which was in the circuit of a seconds pendulum. The sounder was then shut off by a switch and the subject tried to reproduce the same interval of one second fifty times without stopping. The recording instrument used was especially devised at Columbia for this work and has recently been improved (see plate at the end of the thesis). In its present form it utilizes the narrow carbon ribbon of a typewriter and the paper tape of a telegraph ticker for making records with electric pens. The instrument is a clockwork kymograph with a continuous roll of paper tape. The new feature is the band of carbon ribbon (*R*), about a centimeter wide, which runs just above the paper. The record is made by the metal points of electric markers striking the paper against the carbon ribbon. A surface against which this marking takes place is provided by a rubber-covered peg (*A*). Two electric markers give the time line and the record line of the subject's reproduction. The time line is marked by arrow points showing the direction the tape is moving. This is done by shaping the metal head of the electric marker. The apparatus is enclosed in a dust-proof box with a sliding glass side. The kymograph is started by means of an electric magnet (*M*) that raises a rod which rests on the fan governor to stop the instrument. The current through the magnet may be made or broken by a switch in a room where the subject is. This is a decided advantage, as it allows the recording instrument to be placed out of hearing and yet started and stopped by the operator in the room with the subject.[1]

In the following table is given the average length of the one-second interval as reproduced during each of the four succeed-

[1] I wish to acknowledge my indebtedness to Prof. James McKeen Cattell for perfecting this recording instrument. The novel application of a carbon-ribbon to this use was made at his suggestion. It also gives me pleasure to credit Mr. E. Horstmann, the instrument maker at Columbia, with building the special pieces of apparatus used in this research and making valuable suggestions as to their mechanical construction.

ing periods of ten seconds. The average error of each average is also given. The table is averaged from 145 individuals. The variability may be found, if desired, by multiplying the error by the square root of the number of cases.

	1–10 sec.	11–20 sec.	21–30 sec.	31–40 sec.
Average,	.96	.93	.91	.88
Error of average,	.005	.006	.006	.006

The table not only shows that the interval of one second was underestimated throughout the reproductions, but that there was also a rather constant shortening of the period. A comparison of the length of the interval as reproduced during the first ten seconds and as reproduced during the last ten seconds shows that it was shortened .08 sec., plus or minus an average variability of .008 sec. In other words, the chances are even that this interval will be shortened between .07 and .08 sec. during forty seconds' reproduction. This shortening we might suppose is due to the hastening of a process as it becomes more automatic. On the other hand it would probably be a mistake to suppose that as the movement becomes more automatic the feeling of effort during each interval grows less. Mentally the subjects try to keep the feeling of effort alike for each repetition of the interval. Weariness with their task, however, makes a shorter muscular strain seem to amount to the same effort as the longer strain did at the beginning. The above suggestions would be in agreement with an explanation which based the sense of time on kinæsthetic sensations. They are doubtless not the only theory on which the phenomena may be explained, but are offered as harmonizing the facts with the general theme of the paper.

With forty-two subjects a longer series of reproductions was made, extending for two and a half minutes. For this entire period the tendency to shorten the interval is apparent. The shortening is not progressive throughout, nor is any periodic lengthening and shortening brought out by the averages. If there is such a rhythmic fluctuation it is covered up in averaging. An examination of the individual records does not seem to indicate any periodic rise and fall. The table below gives the average length of the 1 sec. interval as reproduced for each

succeeding ten seconds. The average error for each average is given below it.

Period.	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90
Average,	.90	.89	.86	.83	.85	.82	.83	.89	.83
Error of Av.,	.011	.012	.012	.012	.012	.014	.014	.014	.015

91-100	101-110	111-120	121-130	131-140	141-150.
.83	.83	.84	.83	.84	.83
.016	.014	.016	.015	.016	.016

I have already noted that these results are in conflict with the investigations of L. T. Stevens[1] and Nichols,[2] who experimented with multiple reproductions of intervals. They both state that intervals over .7 sec. are overestimated. Stevens tested for intervals as large as 1.5 sec. and Nichols as large as 1.75. We cannot adequately compare Stevens' result as there is no opportunity from his figures to calculate the variability. Nichols' figures would indicate that the chances are even that the overestimation of an interval of 1.25 sec. will be between .03 and .07 sec. This would give a large probability for some overestimation. My own results for an interval of 1 sec. indicate an underestimation considerably greater in amount. With the above series of 42 subjects the average constant error was —.15 sec. with an average error of less than .015 sec. The probability of some underestimation rises here virtually to a certainty. The difference can hardly be due to the fact that Nichols used 1.25 sec. and I used 1 sec. as the standard. His results indicated that the overestimation began at .7 sec. and increased. His subjects reproduced for two minutes, mine for two and a half. I have suggested that the contradiction is best explained by supposing that any slight change in the conditions surrounding a time experiment will make a decided difference in the attitude of the subject.

3. Correlation of Time Judgments and Reaction-Time.

Does a short time interval seem longer to the quick person than to the slow? The question was suggested by Seashore, who inclined to an affirmative answer, although he was unable

[1] *Mind*, XI., 393.
[2] *Amer. J. of Psychol.*, IV., 80.

statistically to measure the relation.[1] By using the Columbia tests it has been possible for me to determine from a group of 140 subjects the exact correlation between reaction time and the reproduction of an interval of one second. In making the calculation the Pearson formula was used.[2] The coefficient of correlation is expressed under this formula as follows:

$$r = \sqrt{\frac{\Sigma xy}{n\sigma_1\sigma_2}}$$

The coefficient is 'r.' The variation of any particular case from the average of one of the correlated functions is 'x,' and its variation from the average of the other function is 'y'; 'Σxy' indicates the sum of these 'xy' products. In the denominator of the fraction 'n' stands for the number of cases, and the sigmas are the mean square variability of the averages of the two functions correlated.

In my calculation I used the subject's reaction time to sound, determined from an average of five trials. This was correlated with the average time in which the subject reproduced an interval of one second when making continuous reproductions for a period of 40 sec. The method of multiple reproduction which I used has been heretofore described. The average reaction time for the group of 140 subjects was .16 sec., with a mean square variation of .02 sec. The average length of the 1 sec. interval as reproduced by the group of subjects was .9 sec., with a mean square variation of .09 sec. The coefficient of correlation was found to be $-.55 \pm .046$. The error of the coefficient is determined by the following formula, the characters having the same significance as in the formula above:

$$\text{Error of } r = \frac{1 - r^2}{\sqrt{n(1 + r^2)}}.$$

The coefficient $-.55$ may be regarded as a high degree of correlation, it being almost as large as the intensity of correlation found by Pearson for physical characteristics. The highest coefficient which Wissler found between reaction time and the

[1] *University of Iowa Stud. in Psychol.*, II., 80.

[2] 'Grammar of Science,' 2d ed., 1900, p. 400.

functions with which he tested its correlation, viz., movement time, association time, marking out *A*'s and naming colors, was .15.[1] The fact that the coefficient is minus shows that those who have greater than the average reaction time (those who are slow) will give below the average length to the interval (make it shorter). If shortening an interval when reproducing it means that it appears shorter, then we must suppose that 1 sec. seems shorter to a slow person than it does to a quick person. As Seashore says: "Time that is associated with his own quick actions seems shorter to the slow person than to the quick person." Curiously enough Seashore seems to turn the correlation about in his subsequent discussion, for he supposes that the slow person overestimates the interval more instead of underestimates it, as my records indicate. If the slow person really overestimated the interval more, we must suppose that it seemed longer to him than to the average person, which would be just the opposite of Seashore's conclusion quoted above. His statement is as follows:

"A comparison of Tables XIII. and XVI. shows that the observers who overestimate the shortest intervals most, tend to have poor motor ability and reaction-time. * * * It is to be regretted that I cannot give a more adequate account of the observations upon this very important point. However, the gauging of the smallest interval by the measured voluntary motor ability, and the information elicited through questions in the extra trials, convince me that this overestimation of the short interval is not due to inability to act quickly enough, but it is a normal illusion in the perception of the standard interval. The evidences warrant the conclusion that the time that is associated with his own quick actions seems shorter to the slow person than to the quick person. Does the slow boy realize how long an interval elapses before he begins to reply to the teacher's question? And, when he has once started, do the intervals between his words seem as long to him as they seem to the quick boy at his side? The lagging of a slow person in all rushing activities does not seem as great to him as to the quick person. Persons who are habitually too slow in their quickest actions have established erroneous associations between standards of time and the time of their own actions."[2]

If the latter part of this statement is true, it is apparent that the slow person must underestimate more than the average. Whether the slow boy would show this same tendency to shorten the interval if he merely judged the interval without reproduc-

[1] 'Correlation of Mental and Physical Tests,' *Monog. Sup. Psychol. Rev.*, 1901, III., 61.

[2] *Op. cit.*, p. 80.

ing it, we cannot say. We should expect the same tendency to hold and are probably justified in supposing that the interval is actually perceived differently by the slow boy. We are certain that there is a correlation as to the reproduction of the interval. In this correlation we have again an indication that time estimation is dependent in some intimate way on the muscular reaction of the individual. This is theoretically the most important feature of this correlation.

This tendency of time estimation and reaction-time to go together has a further bearing on all investigations of time. It provides a definite grouping in which subjects who underestimate or overestimate intervals may be classified. We know that there are specific classes of people who are characteristically different in this function. If, then, an investigator has unintentionally selected a group of subjects with quick reaction-time, their judgments on short intervals will show a plus tendency from the average time estimation. This may give us a hint toward explaining the differences that have arisen between the results of different investigators. It would be especially important where results are published for only one observer. It shows the desirability of having groups large enough for the effect of such a selected class to be eliminated.

In everyday life the fact that an interval appears longer to a quick person has numerous applications, as Seashore suggests. Speakers who adapt themselves to slow hearers may find themselves tedious to the quick members of their audience. The beating of a baton of an orchestra leader may be more confusing to the slow person because the time seems more rapid. On the other hand the rapid person, we should expect, would really play more slowly on his instrument because the time of the leader seems slower to him. He lengthens the interval in reproducing it. The same principle would appear in connection with the operation of any machinery where rhythmical movements were required. Paradoxical as it may appear, the slow person seems actually to be faster if left to keep up a regular movement. Reaction-time might even become a test for selecting slow employees to make fast rhythmic movements or quick employees when it became necessary that short times should seem longer and less confusing.

PART IV. APPLIED RHYTHMS.

The intimate relation between rhythm and work opens numerous inviting avenues for experiment. The investigation of memory by Ebbinghaus at once suggested a connection with rhythm.[1] Subjects were found to group nonsense syllables as they learned them. This factor was studied further by Müller and Schumann, who observed a loss of almost half when rhythm was eliminated from the memorizing process.[2] That rhythmic grouping may increase the span of consciousness was shown by an ability to compare accurately large groups of successive stimuli, when these were broken up into smaller rhythmic units.[3] Scripture has called attention to the relation between natural rhythms and periods of work. When the two coincide we get the 'most action with the least fatigue.'[4] This is recognized in the 'rout step' of troops on long marches, when each man chooses his own pace.[5] It has been a favorite pedagogical method to utilize rhythms in memorizing the multiplication table, the names of the presidents, etc. An interesting collection of these rhythmic memory helps has been made by Sears.[6] Féré has recently published an excellent experimental study measuring the amount of work done on the ergograph when pulling in different rhythms. Particularly striking is the rapid fatigue following an increase in work when using certain rhythms.[7] The most extended laboratory study of 'Rhythmus und Arbeit' is that of Smith.[8] Besides comparing the effect of different rhythms

[1] 'Ueber das Gedächtniss,' Leipzig, 1885.

[2] 'Experimentelle Beiträge zur Untersuchung des Gedächtnisses,' Leipzig, 1893.

[3] James, 'Principles of Psychol.,' I., 407, reference to work of Wundt, Dietze, Bechterew, etc.

[4] 'New Psychol.,' p. 181.

[5] *Studies from the Yale Psychol. Lab.*, VII., 107.

[6] *Amer. Jour. of Psychol.*, XIII., 28 ff.

[7] *L'Année Psychol.*, 1902, VIII., 49 ff.

[8] *Philos. Stud.*, XVI., 71 ff.

in oral and visual memorizing, she opened up several other fields for the application of rhythms to work. Her experiments with writing in regulated rhythms and those with judging weights lifted in rhythms are explorations in new territory where trial alone can tell us whether we shall here discover new ways to increase ability.[1] If the ultimate aim of scientific inquiry is to increase human efficiency, considerable time must be occupied in psychological exploring. Should a small fraction be added to the productivity of individuals in even one activity the reward will be great. The general problem, how to increase efficiency, carries with it a somewhat simpler problem, how to improve most rapidly. We are constantly testing various methods of training and working out by the slow rule of thumb the method best adapted to speedy improvement. Rhythm appears as one of the most promising guides pointing into the future. Our general knowledge of this phenomenon affirms its economical value in all activity. When seeking for increased ability or more rapid improvement we may hope for success if the work in hand can be adapted to a rhythm. May a person not learn to use a typewriter more quickly if the keys are operated in a rhythm? May rhythm not be utilized in learning to spell long words? Suppose the child should say, 'M-i′ double s-i′ double s-i′ double p-i′,' would he not more quickly get the correct spelling of the word? The use of rhythm might save us many a stumble in articulation. We know that rhythm is necessary to pronounce many words and has worked itself into difficult combinations of syllables through primary and secondary accents, *e. g.*, pres′-ti-dig′-i-ta′-tor. Pleasing prose sentences probably maintain a rhythmic balance. We have only made a beginning in the investigation of the relations of rhythm to poetical thought. Numerous other possibilities for the adaptation of rhythm to mental activities will suggest themselves.

The two series of experiments which I shall report may be considered as explorations in this wide field of applied rhythms. I have varied the usual method by trying to find the effect of

[1] As this thesis is going to press, another paper on 'Arbeit und Rhythmus,' by Von Dobri Awramoff, *Philos. Stud*, XVIII., 515–563, has just been published. It treats of the effect of rhythm on the ergograph pull, reaction-time and writing.

an independent rhythm on mental activity, instead of having the subjects work in a prescribed rhythm as other investigators have done. In the first series of experiments I tried the effect of requiring subjects to supply words in the blanks left in a poem, while they were themselves continuously beating a rhythm with the fingers of the hand not used in writing. This gave the effect of an independent motor rhythm on a complex mental activity. In the second series I tried the effect of the rhythmic beat of the metronome, which was sounded rapidly or slowly beside a person, while he was distributing a pack of playing cards in the four suits. This showed the change produced by an objective rhythm on a rather simple mental activity in the nature of a continuous choice reaction. The rhythmic accompaniment in each experiment was thus in no way connected with or adapted to the work performed. Both series were conducted with groups of over a hundred subjects, so that I was able to work out definite correlations which proved to be the most valuable results of the investigation. The effect of the independent stimuli on the average amount of work done was slight, but the correlations led to the interesting discovery that rhythms affected the naturally slow person and the naturally quick in a decidedly different manner. The slow person, under rhythmic stimulation, tends to improve in efficiency, while the quick person tends to lose very decidedly. I shall discuss the results further after describing the experiments.

1. Effect of a Rhythmic Movement on a Complex Mental Activity.

This series of experiments was suggested by the common observation that many people make slight rhythmical movements while conversing, lecturing, or engaging in mental work of various kinds. The movements are usually with the fingers, such as tapping on a table, handling a watch charm, etc. The story is related of a German professor who was obliged to dismiss his class when he found that some one had cut off the coat button he was accustomed to fumble while lecturing. May we not get some clue to the effect of these movements on mental activity? If a satisfactory test for intellectual work could

be found, it would be a simple matter to compare the records of subjects made normally with those made while the same subjects kept up a constant tapping with their fingers. The test which I decided upon consisted in requiring the subjects to fill words in blanks which were left in the verses of Stevenson's poem 'The Dumb Soldier.' It was necessary that each subject should make the test with and without the motor accompaniment, so I divided the poem into two parts. These were mimeographed on separate sheets of paper from a typewritten copy. Each part started with the first stanza of the poem, given completely, so that the meaning of the piece might be easily grasped. Five blanks were left in each of the other stanzas. The two parts, except the first stanza, are printed in parallel below.

When the grass was closely mown,
Walking on the lawn alone,
In the turf a hole I found
And hid a soldier underground.

Spring and daisies —— apace;
Grasses —— my hiding place;
Grasses —— like a —— sea,
O'er the lawn up to my ——.

—— the grass is —— like grain,
When the scythe is stoned again,
—— the —— is shaven clear,
Then my hole —— reappear.

He has lived, a little thing,
In the ——woods of —— ;
Done, if —— tell me true,
Just as —— should like to ——.

In the silence he has ——
Talking bee ——ladybird,
And the butterfly has ——
O'er —— as he —— alone.

Under —— alone he lies,
Looking up with leaden ——.
Scarlet —— and pointed ——,
To the stars —— to the sun.

—— shall find him, never fear,
I —— find —— grenadier;
But for all that's gone and come,
I shall ——my soldier ——.

He has seen the starry ——
And the —— of the flowers
—— the fairy things —— pass
In —— forests of the grass.

Not a word —— he disclose,
Not a word of all he ——.
I must lay —— on the ——,
And make up the —— myself.

The subjects for the experiment were students in the high school at Berlin, Wisconsin, and were quite evenly distributed through the four grades. Records of 102 subjects were obtained. The tests were given to a class of from 15 to 20 at a time. The directions were read to each group to be sure that they were always given in the same way. I conducted all the tests myself, thus

further insuring uniformity. The subjects were carefully cautioned to begin at the first and not skip any blanks, to place only one word in each blank, and to be sure that the word supplied made sense in the line of the poem, but to pay no attention whether it made sense with the preceding or following lines. At a given signal they began and wrote as rapidly as possible until they were told to stop (85 seconds). When the work was to be done with the rhythmical accompaniment the subjects were told to tap gently on their laps or papers with the fingers of their left hands. I kept watch and warned them to keep up the tapping whenever I found that any one stopped. In half of the groups the test was made first with the rhythmic stimulus and afterward without it. In the other half the normal test was made first and the stimulus afterward. To further eliminate any effect of practice or difference in difficulty between the two parts of the poem each alternate person was given the first part of the poem and his neighbors the other part. By this means the two parts of the poem were used equally in all the forms under which the test was given, so that any difference between them was eliminated in the averages. The test proved to be very satisfactory. The difference in difficulty between the two parts of the poem was on the average only .5 of a word. Only one subject succeeded in filling all the blanks in the time allowed. After finishing the tests each subject was asked to write on his paper whether he thought the rhythmic accompaniment had made the work harder or easier, or had no effect. There were 56 who thought it was harder with the movement, 19 thought it was easier and 27 thought there was no difference. Of these 102 judgments it is interesting to note that only 58 were right, as judged by the objective results. This is partly accounted for by so many stating no effect from the movement.

The results of the tests were as follows. Normally the subjects wrote on an average 4.7 words. The mean square, or standard, variability of this average was 3.3. The standard error, found by dividing by the square root of the number of cases, was .3 word. On the whole the number of words written under stimulus was less. The average loss was 1.1 word, with

a standard variability of 3.2 and error of .3. That is to say, the chances are .68 that the average loss under rhythmic movement would be $1.1 \pm .3$ word.

Interesting as this result may be, it is overshadowed by the discovery that the loss is far from uniform for different kinds of workers. The tendency is for the principal loss to fall upon the subjects who normally made an excellent record. Those who were naturally slow in this kind of work seemed to gain slightly under the motor stimulus. Grouping all the individuals who normally did better than the average, I find that in the test with tapping they lost on an average 3 words, plus or minus a standard error of .4 word. On the other hand those who normally wrote less than the average of 4.7 words, wrote an average of $.9 \pm .3$ word more when using the motor accompaniment.

To place this result in a more general form I have calculated the correlation between the records of the same subject as to his variation from the normal average and his variation under the rhythmic accompaniment from the average loss of 1.1 word. Using the Pearson formula the correlation was found to be .75, with a standard error of .04. This means that there is an exceedingly strong tendency for the subjects above the average in the normal test also to be above the average in the amount of loss under the stimulus. On the other hand those below the average normally lose less than the average, even tending to show an average gain with the motor accompaniment.

By using the coefficient of regression we may calculate what will be the average of any array in the correlated trait. The coefficient of regression ($\mathcal{Q}$) is determined as follows:[1]

$$\mathcal{Q} = r \frac{\sigma_1}{\sigma_2}.$$

In this formula r is the coefficient of correlation, σ_1 the mean square variation of one of the correlated traits from its average, and σ_2 the mean square variation of the other trait, in which it is sought to find the regression toward the average. Since in the above correlation the two sigmas are 3, $\mathcal{Q}$ will

[1] Pearson, 'Mathematical Contributions to the Theory of Evolution,' *Philos. Trans. of the Royal Society*, London, 1896, CLXXXVII., 268.

equal r and be .75. We may then say that those who write, for example, three words more than the average will tend to show $3 \times .75$, or two words more than the average loss under the rhythmic stimulus. Since the average loss was one word, they will tend to lose 3 words. It will be noted that this agrees with the empirical results stated above. The advantage of the coefficients of correlation and regression is that they make it possible to determine by a simple calculation the position of any selected part of the group of individuals in the correlated trait. Moreover, the coefficients are the most accurate methods of description.

2. Effect of an Objective Rhythm on Choice.

In the following experiments I used for a continuous choice reaction the distribution of a pack of playing cards in the four suits: spades, clubs, hearts and diamonds. After each distribution the pack was shuffled carefully three times so as to get a chance arrangement as nearly as possible. The experiments were to test the effect of the rhythmic beating of a metronome upon the work done by the subjects in distributing the cards. A series of records was taken when the subjects were working normally, another when the metronome was beating at the rate of 40 per minute with the bell sounding on every alternate beat, and a third series with the metronome beating 200 per minute with the bell on every alternate beat. One of these rates was slower and the other considerably faster than the speed at which the subjects distributed the cards. The metronome was placed on a sounding box to make it louder. In each test the cards were to be distributed as rapidly as possible for 25 sec. The subjects, 119 in all, were students in Teachers College, Columbia University. They were divided into groups of ten. The members of a group arranged themselves conveniently around a large table. They were directed when they distributed the cards to arrange the four suit packs in the form of a square; the two packs farther away to be the red suits and the two nearer packs the black suits. This avoided any variation there might be from different arrangements of the suits when distributing. Three tests were made on each subject without

the metronome, three with the metronome beating 40 and three with it beating 200. Instead of using the average of the three tests I found it best to use the middle or median record. A single record was frequently seriously disturbed, but by using the median record I believe a fair test was obtained for my purpose of correlating the work of the subjects under the three methods. The conditions were varied after each distribution of the cards, so that the practice effect would be equally distributed through the three forms. For example, if the subjects began without the metronome, the next time they distributed with the metronome 40, then with it 200, then without, etc. Each group of ten subjects began differently so as to further eliminate practice effects.

Taking up first the results for the continuous choice reaction made normally with that made when the metronome was beating 200 per minute, we find that without the metronome the subjects distributed in 25 sec. an average of 40 cards, with a mean square variation of 6 and a standard error of .6. Under the stimulus of the 200-rhythm they gained on the average .7 card, with a standard variation of 3 and an error of .3. I have calculated the correlation between the records of each individual compared with the normal average and with the average gain. The coefficient of correlation was —.32, with a standard error of .08. This means that those who normally distributed more than the average number of cards tended to fall below the average gain when they were under stimulus. We may calculate the coefficient of regression ($\mathcal{Q}$) under the formula given previously as follows:

$$\mathcal{Q} = -.32 \times \frac{6}{3} = -.6.$$

From this we can say that those who normally distributed 5 cards, for example, more than the average, would tend to be $5 \times -.6 = -3$ from the average gain under the stimulus. Since the average gain was .7, they would be in the position $-3 + .7 = -2.3$, or they would lose on the average 2.3 cards. On the other hand those who normally were slow, say 5 cards below the average, would tend to gain on the average $3 + .7 =$

3.7 cards under the rhythmic stimulus. We see, therefore, that the opposite effect is considerable on the two classes of individuals below and above the average in this sort of mental work.

The results with the rhythm of 40 beats per minute were as follows. The average gain under stimulus was practically nil. Accurately, it amounted to .3 word, with a standard variation of 3.5 and a standard error of .3. The opposite effect on the two classes of individuals, the quick and the slow, was again quite noticeable. The correlation, calculated as before, was —.39, with a standard error of .07. This would give a coefficient of regression of about .8. Using the same example as above, we can say that those who normally distributed 5 cards more than the average would tend under the 40-rhythm to lose on the average 3.7 cards; while those 5 cards slow compared with the average will tend to gain on the average 4.3 cards.

It might be supposed that familiarity with the use of playing cards would seriously disturb the results in an experiment like the above. To determine if this was likely I asked each person to grade himself as *A*, *B*, *C* or *D* as to his familiarity with cards. '*A*' meant that he was very familiar and '*D*' that he had almost never handled cards. Out of the 119 subjects only 7 classed themselves *D* and 12 classed themselves *A*, so that the mass of the subjects were in the middle grades. I have examined the '*xy*' products of these 19 extreme subjects (see formula for the coefficient of correlation under the correlation of time judgments and reaction-time), and I find that in both the correlations calculated the products of these individuals are very near the average. The amount of correlation shown in no way rests upon the records of these individuals. I think, therefore, that we may fairly hold that familiarity with cards did not disturb the result arrived at. Another factor that should be considered in the above test was that ten of the subjects, according to their median records, distributed all the cards in at least one form of the test. Two of these distributed all the cards under each form of the test. Of course we cannot tell how many more cards these people might have distributed, but the cases are so few and the difference would have been so small that the error is negligible.

To see what effect the subjects thought the metronone had upon their work I asked all of them, after they had finished the tests, to state under which conditions on the whole they thought they made the best record. As the subjects had not kept their own records they could answer only from such impressions as they had gained while making the tests. The answers were as follows: Best without metronome, 34; with metronome slow, 28; with metronome fast, 25; no difference, 32. In each of these cases about half of the answers agreed with the median records of the subjects. Judging by these records the number who actually did best under each form of the experiment was as follows: Without the metronome, 30; with slow metronome, 39; with fast metronome, 40; two out of three forms alike, 10.

3. Summary.

A rather important principle as to the relation between mental work and an independent rhythmic stimulus seems to be pointed out by the above experiments. On the whole the slow person is quite likely to profit from an independent rhythmical stimulus, while the quick person is very much disturbed. Thisseems to hold for the simpler mental activity of distributing cards as well as for the complex exercise of supplying words for blanks left in a poem. The conclusion is supported by a correlation of .75 in the poem test between normal work and the effect produced by a rhythmic motor accompaniment, also by correlations of — .32 and — .39 in the experiment with choice between the records in the work done normally and the gain made under an objective sound rhythm. A hint as to the possible explanation of this result is suggested by the difference in attentive attitude of slow and quick subjects. A person who is above medium in any mental activity will attend to it more keenly; will, as it were, be keyed to a higher pitch, or be in a state of more sensitive equilibrium. Any independent, secondary stimulus would thus serve seriously to disturb such a subject. To speak figuratively, he would have the edge taken off his attention. On the contrary the subject who does mental work indifferently will be excited by the rhythmic accompaniment and spurred to greater effort. The independent stimulus, which is

ordinarily supposed to be distracting, seems in the latter case to favor more rapid work. The discovery of these two classes of individuals, who show contrary tendencies while working under independent rhythmic stimulation, suggests that we are always in danger when we suppose that a method of increasing efficiency which is valuable for one person will be valuable for another. While it may be of advantage for the keenly attentive person to work in a quiet room and to inhibit all extraneous movements, these experiments indicate that for the slow person independent sounds or accompanying movements might even be an advantageous means of quickening mental activity. Perhaps we are making a serious mistake to insist that scholars keep quiet while working in school. It may be that what we call 'nervous movements' in their case drain off superfluous energy and allow their brains to work more actively. It is at least strongly suggested by these experiments that in the quick and the slow individuals we have two groups who require decidedly different treatment if they are to reach their highest efficiency.

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The Perception of Number

BY

J. FRANKLIN MESSENGER, M.A.

[Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in the Faculty of Philosophy, Columbia University, and being Vol. XIII., No. 1, of Columbia University Contributions to Philosophy, Psychology and Education. The results of this research were presented before the Section of Anthropology and Psychology of the New York Academy of Sciences, and the monograph is published under the auspices of the Academy.]

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EDITED BY

J. MARK BALDWIN, PRINCETON UNIVERSITY AND J. MCKEEN CATTELL, COLUMBIA UNIVERSITY

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CONTENTS.

THE PERCEPTION OF NUMBER.

INTRODUCTION.

The experiments upon which this work is based were begun in Harvard University and later were carried on in the laboratory of Columbia University. Part of the results have already been published in the Harvard Psychological Studies, Volume I. It is my purpose in this paper to report some additional experiments and give a more extended theoretical discussion of the questions involved.

The experiments already published had reference entirely to the perception of number through touch. In this report I shall give a brief summary of such of those results as may be useful in the discussion, add a few more from the same field, and then report some experiments on the sense of sight which were intended to throw light on the same general problem.

The investigation began as a study in the fusion of touch sensations when more than two contacts were possible. I had no very definite idea of what 'fusion' meant, and I am even yet unable to find in psychological literature a satisfactory definition or explanation of it. In the absence of uniform usage or common understanding of the term I shall state my own views in regard to fusion in general, in order to make perfectly clear what I mean when I deny that there is fusion of touch sensations when two objects resting near together on the skin are perceived as one object. Inasmuch as the attitude of the subject plays so important a rôle in all of the experiments, it will be necessary also to devote a few paragraphs to the relation of the motor to the sensory elements of consciousness. The conclusions of other experimenters with whom I do not agree also suggest some remarks on that subject.

FUSION.

In Külpe's 'Outlines of Psychology'[1] I find this statement: "If the connected elements are temporally and spatially identical,

[1] English translation by Titchener.

but differ in quality, their connection must be termed fusion; if they differ in duration or extension, colligation."[1] I do not find this distinction useful. If we revolve a black and white disk on a color mixer the elements become temporally and spatially identical. To be sure, there is externally a rapid alternation, but the duration of retinal processes makes the result the same as if the gray were made by actually mixing the pigments. Elements so mixed are sometimes said to 'fuse,' and I presume it would be misleading to deny that meaning to the word. I should prefer, however, a more restricted use of the word, and to call it fusion when two or more qualites are inseparably connected so that one cannot be perceived without the other, *e. g.*, pitch and timbre, color-tone and brightness, and, so far as sight is concerned, color and extension. When two or more elements, which might, under other conditions, be perceived separately, are so connected that their combined effect produces a single quality of sensation, we certainly have a combination of a very different sort, and it is with reluctance that I apply the same term to it. To avoid confusion I should prefer to call it a mixture instead of a fusion. As an example of this, red and yellow mixed give the sensation of orange, which is a single quality of sensation entirely distinct from the other two. With what Külpe calls a colligation I have nothing to do in this connection. A place will be found for that later. It will be noticed that in the above the matter of spatial identity is left entirely out of account. As a matter of fact, two elements which are not spatially and temporally identical usually *can* be perceived separately, and hence do not fuse. It does not follow, however, that they *are* perceived separately; it is sufficient if they *can* be.

Külpe says: "A stimultaneous connection of tones may stand as a typical example of fusion. Colligation occurs, on the other hand, when the cognizability of the separate qualities is either unaffected by combination, so that they retain their original independence, or is actually increased." An important factor, it seems to me, is left out of this classification, viz., the distinction between having a sensation and perceiving an

[1] The German word is *Verknüpfung*.

object. We must also distinguish between qualities which can be conceived separately and those which can produce sensations separately. We can conceive color-tone separate from brightness, but we cannot have a sensation of pure color except when fused with brightness. On the other hand, we can not only conceive each separately but we can also have a simple sensation of red or of yellow or of orange.

It should be noticed in connection with Külpe's statement that 'a simultaneous connection of tones' might be produced by two tuning forks vibrating at the same rate, although their combined effect is a sensation of a single quality. In that case the only way we could recognize fusion would be by finding out the number of objects producing the sensation. However, Külpe's definition of fusion quoted a moment ago excludes such a combination, because they do not differ in quality. But suppose we have one fork vibrating at the rate of two thousand times per second and the other at the rate of two thousand and one times per second. The qualities must be different, and hence the tones fuse; but the difference in the qualities is not perceptible, hence experience could never discover the fusion and we could find it out only by calculating the number of vibrations. According to my classification neither of these cases would be fusion, because either of the two elements could be perceived separately, *i. e.*, neither exists by virtue of the other nor is either in any way dependent upon the other.

Perhaps the question is largely one of nomenclature, but the term fusion has been used in such wide and often vague senses that I think it necessary to state certain distinctions which seem to me to be fundamental. If any one wishes to indicate the distinctions by other terms than those I use I have no objection; but I do insist on the distinctions which my classification emphasizes, however they be designated.

The classification briefly stated is this: There are three kinds of combinations which are fundamental in explaining the relations of consciousness to the external world.

1. Elements may be inseparably connected for perception yet separately conceivable, *e. g.*, pitch and intensity of sound. Neither of these can be perceived without the other, but we can

perceive a variation in one without any variation in the other, hence we come to conceive them separately. This represents the most intimate connection of elements possible and might be called fusion proper.

2. Elements which can be perceived separately may be combined so as to produce an entirely new and distinct quality of sensation, *e. g.*, red and yellow produce orange. In this case a variation in one of the elements produces a variation in the quality which results from the combination of the other two. In this class two qualities combine to produce a third, while in the first class the combination of two elements does not produce a third. It must also be noticed that in the first class each element exists by virtue of the other, and in the second class neither of the original elements entering into the combination owes its existence to the other, but the third quality exists only as the product of the other two. This is a much less stable combination than the former and might be called a mixture. And furthermore, it includes combinations of the first class and thus really represents combinations of a second order.

3. There remains another class of combinations which, for want of a better term, I shall call constructive combinations. By this I mean the combination of different qualities to form a single object. The qualities may be either different qualities of the same sense or of different senses, *e. g.*, we may, by using a single sense, combine weight, hardness, etc., to form an object, or we may, by using two senses, combine color, weight, etc., to form an object. There are many kinds of constructive combinations and one might attempt to classify them, but I am not sure that he could find any very satisfactory basis for such a classification. It will be noticed that this class includes those combinations of sensations of different senses which have sometimes been called 'complications'; but it also includes more than that and it is not determined by the same characteristics.

There is still another way of experiencing the external world, which at first thought might suggest a fourth class of combinations. We sometimes perceive objects in groups, and this grouping might be called a combination of elements into a

whole. I regard this, however, as an altogether different sort of experience, and to describe that experience is the principal object of my present work.

The perception of objects in groups, then, is the question I am studying. The only excuse for saying anything about fusion is that some writers have said that there is a fusion of sensations when two objects are perceived as one. This I have already denied and have given the reasons for so doing. I wish now to take that as a starting point for further discussion, and have given the above scheme for psychological analysis as a means of orientation. My attention has been confined entirely to the senses of touch and sight because the world of external objects is, for the most part, a sight-touch world. Many experiments have been made on the grouping of sounds which are heard in succession, but I am interested only in that which can be given *at once*, *i. e.*, simultaneous stimulations. Sounds of different qualities might be used simultaneously, but I have not tried them.

Experiments on Touch.

I give below a summary of such of the results already published as may be referred to here:

1. Contacts on the back of the fingers are much more easily distinguished when the fingers are spread than when they are close together.

2. If fingers of opposite hands are brought together by interlacing them and two contacts are given on contiguous fingers, they are quite as likely to be perceived as one when the fingers stimulated belong to opposite hands as when they are contiguous fingers of the same hand.

3. There is almost as much tendency to overestimate the number of contacts as to underestimate it.

4. When four contacts are made at a time, one on each finger, certain arrangements are likely to be overestimated while other arrangements are likely to be underestimated.

5. A subject may distinguish a qualitative difference between two points of the æsthesiometer and one point, even though he does not distinguish a difference in number of points.

6. A subject may be led to lose the distinction between the

sensation of one and the sensation of two, and the *Vexirfehler* may be made to appear in a large percentage of cases.

I have attempted to explain these phenomena on the basis of localization and association.

When two exactly similar contacts are given and are perceived as one we cannot be sure whether the subject feels only one of the contacts and does not feel the other at all, or feels both contacts and thinks they are in the same place, which is only another way of saying he feels both as one. It is true that when asked to locate the point he often locates it between the points actually touched, but even this he might do if he felt but one of the points. To test further the matter of errors of localization I made several series of experiments in which I used qualitatively different contacts. This enabled the subject to feel and to report both contacts. For this purpose I took two brass rods about four inches long, sharpened one end and rounded off the other. The subject sat with the palm of his right hand on the back of his left and his fingers interlaced. I stimulated the backs of his fingers on the second phalanges with the sharp end of one rod and the blunt end of the other, and asked him to tell whether the sharp point was to the right or to the left of the other.

The results and observations of the subjects were interesting and very suggestive. I do not think, however, that they can be tabulated in a way to make them significant. They afford, rather, a means of studying the mental habits of the individual. So far as I can see there is no uniformity in the number of errors made, but there were certain types of errors which occurred with all subjects, and individual variations seemed to be fairly well explained by their subjective analyses. When the stimulated fingers were separated by two or more intervening fingers, naturally there was no difficulty in answering correctly, but when the stimulated fingers were adjacent, and often even when one finger intervened, mistakes were made. I usually gave thirty stimulations in a series and allowed only a few moments' rest between each separate stimulation. The percentage of errors is not particularly significant, because some of the contacts were made so far apart that they were judged correctly

as a matter of course. It is the type of errors and the subjects' introspection that are significant. The first thing noticed was that many of the answers were wrong. These errors may be due to any one of three causes. If the subject has no means of determining the direction his answer must be a matter of chance, and sometimes it would be right and sometimes it would be wrong. Chance, no doubt, is the principal factor in many cases. This means, then, that in so far as it is a matter of chance the direction is not really determined. But still the question remains, why can he not tell? When the points are on different hands we must conclude that he has forgotten the relation of his fingers, or that he does not know which fingers are touched, or that he recognizes two qualities of sensation and knows that they are on different fingers and knows the space relations of his fingers but fails to associate the right quality of sensation with the right finger. Any one of these factors would prevent a correct judgment, or all might work together to interfere with it.

There seems to be no evidence that he actually forgets the relation of his fingers, but it is probable that it requires some effort of attention to keep that relation in mind. He has not the relation so firmly established in his mind that he can fit a new experience into it without conscious effort.

There is some evidence to indicate that he does not always know which finger is touched. Mistakes are made in locating. He will often locate a contact on the wrong finger, and often on the wrong hand. This occurs only when two or more contacts are given at once. At least I have never observed it when but a single contact was given. Furthermore, it makes a great difference if the subject is told to notice which hand is touched by each point. If he is judging direction and is unexpectedly asked to name the hand he may not be able to do it. I made some experiments with the same instruments, only asking the subjects to tell if the points were on the same hand, and if not, on which hand was the sharp point. This they could do with scarcely any mistakes. There was some hesitation at first, apparently due to the fact that they had become used to judging direction and it took them a few minutes to adjust themselves to the new experiment, and occasionally there was an answer of

'same finger' when the contacts were on fingers of opposite hands. It will be noticed that in this experiment there was less to be attended to than in the other one. Only two factors enter into these judgments: first, are both hands involved, and second, on which is the sharp point.

The third disturbing factor mentioned above, viz., the failure to associate the right quality of sensation with the right finger, is a matter of some importance, for it undoubtedly does occur and it seeks an explanation. The explanation, I think, is found in the narrowness of consciousness. The recognition of two qualities is a simple matter, and the recognition of the relation of the fingers is not very difficult on account of the long training we have had and the associations that are already formed, but when we are required to hold these in mind and make still other associations between them the process becomes too complex unless it can be done step by step. It cannot always be done step by step, because the sensations fade away too rapidly, even when the stimulating objects are left on as long as the subject wishes. The tendency to move the fingers, which I think has been noticed by all observers, is due to a desire to restimulate in order to notice by itself some doubtful element. I once thought this tendency to move was evidence of the motor element of sensation, but I do not now regard it so. If the subject had control of the stimulating object I think he would just as soon move it, but inasmuch as he cannot do that he moves the only thing he can control, viz., his own fingers. If the operator would repeat each separate stimulation whenever the subject wished, that would answer the same purpose. I postpone further discussion of this question until I have more fully described the experiments.

Besides positively misjudging the direction it was quite common for a subject to say that both points were on the same finger when they really were on different fingers. This was as likely to occur when the points were on fingers of opposite hands as when they were on fingers of the same hand. In fact, I believe that when the hands are in this position there is greater probability of having contacts on corresponding fingers of opposite hands judged on the same finger than there is when the

hand is in normal position and the contacts are made on adjacent fingers of the same hand. I have not made the necessary experiments to speak positively about this, however. This may be because there is less qualitative difference in the sensations of corresponding fingers, or it may be that the fingers of each hand are in their customary relation to one another, while the fingers of one hand are in an unusual relation to the fingers of the other hand. Probably each of these factors has some effect, but I think the error is chiefly due to the latter.

One would naturally expect the reverse error to occur quite often. It did occur, but not so frequently as I expected, considering the success I had had in developing the *Vexirfehler*.[1] I did not make many efforts to induce this error, but in those I did make I was not successful. Instances occurred occasionally in the natural course of the experiments, but I was not able to discover any conditions which would enable me to anticipate errors of that kind. They occurred unexpectedly, just as the *Vexirfehler* did before I learned how to produce it. I believe that with sufficient practice one could learn to arrange his experiments in such a way that the subject would mistake one finger for two in a comparatively large number of cases.

In many cases I was able to anticipate the answer 'same finger' when two fingers were touched. The easiest way to lead a subject to do that was to put one point farther toward the end of the finger than the other. This brought one of them nearly in front of the other and also attracted his attention to a different direction from that he was asked to judge, and, perhaps, rendered it more probable to his mind that they were on the same finger. It often occurred, though, when the points were directly opposite one another. I will give the figures for one subject for one day the first time I tried that method. I first made a series of thirty experiments in the usual way, having the points about opposite each other. In nine cases the judgment of direction was wrong, and once he said the two points were on the same finger. This was rather a high percentage of errors, though not the highest I ever obtained. It was followed by a series of thirty experiments in which one

[1] Reported in *Harvard Psychological Studies.*

point was always farther front than the other. In this series there was one wrong judgment of direction, once he was unable to answer, and seven times he said 'same finger.' So far the contacts had all been made somewhere near the median line of the fingers. On another day with the same subject I made a series of thirty experiments in which some of the contacts were toward the side of the fingers, and one of them always nearer the end of the finger. In this series he answered 'same finger' once when two fingers were touched, twice when the points were on the same finger he failed to recognize that they were both on one finger, and nine times he made errors of direction of the following type: *E. g.*, I put the blunt point on the second finger of the left hand and the sharp point toward the thumb side of the third fingers of the right hand (the right hand was on top of the left and the little fingers outside the index fingers). He answered that the sharp point was to the right, which was correct. I then put the blunt point down again in the same place and the sharp one on the ulnar side of the second finger of the right hand, and he still answered that the sharp point was to the right, which was not correct, but he thought that the sharp point touched the same place both times. The blunt point was in the same place, and he did not notice the changed position of the sharp point. It will be observed that the two places touched by the sharp point are normally near together and were not very far apart during the experiment. A slight variation in the experiments was afforded by asking the subject to clasp his hands so that the second phalanges were even and formed a tolerably continuous surface. The results were of the same sort as in the former cases. If two fingers of the same hand are touched and then one of the points moved to the finger of the other hand lying between them, the subject is likely, in the latter case, to say both points are on one finger. In the first case the contacts were on fingers which are normally adjacent. When one of the points was moved toward the other it was rather natural to have the feeling that it was on the same finger as the other point. Several hundred judgments were obtained from the same subject, but, as said above, the percentage of errors is not significant unless the exact locations of the points are given for

each experiment. So far as I am able to judge, the results mentioned are representative.

With other subjects the results were of the same character. The individual differences seemed to be rather differences in method than in results. One subject took much longer time than the others to make his judgments. He is not a man whose normal reactions are slow. In fact, I should say he is above the average in quickness of thought and action. He seemed to be very careful about his answers and was much disturbed when he thought they were wrong. He made fewer mistakes than the others, but those he did make were of the same sort. He seemed to consider all of the data at his command before answering. When the answer did come it seemed almost as much the product of reasoning as of direct perception. He could more easily and more quickly tell which hand each point was on than he could tell the direction of one from the other. By questioning him in regard to his habits I learned that he does not usually think of things as situated on the right or left of himself, and when he does want to know he has to stop and think which is his right side. When he drilled in a military company he had some trouble learning to start with his left foot, and when he did learn it he did not remember it as *left* but remembered it as *that foot*. It may be that this is about what we all do, but there are, no doubt, differences in our ways of regarding the relation of objects to ourselves. Most persons could judge the direction of the points more quickly than they could judge which hand each point was on. It seems to depend entirely on the habits of the individual.

We must find out the position of the object by means of the part of the body which is stimulated, but we need not be aware of the bodily part at all. In the case of sight we scarcely ever are. If we look at one object with one eye and at another object with the other, we cannot tell directly which object casts its image on the right eye and which on the left. If one object is at the extreme right of the field of vision and another is at the extreme left, the former is seen by the right eye and the latter by the left eye, but the observer cannot discover this except by closing one eye and then the other and noticing the disappear-

ance of the objects. If the eyes were not trained to coördinated movements, and if we were not trained to perceive in a single visual field that which comes to us as two separate sensations, we should be able to recognize directly which objects are seen by the right eye and which by the left. The movements of the hands are sometimes coördinated and sometimes they are not, sometimes two sensations mean two objects and sometimes the same two sensations mean one object. Two fingers may touch a pencil and it feels like one; spread the fingers and with two pencils touch the fingers in exactly the same way that they were touched by the one pencil, and we feel them as two objects, not because the stimulation is different but because we know the fingers are spread and one object could not be in two places. With the eyes we locate objects in relation to one another — one's own body being one of the objects. In so far as we do that with the hands it matters no more which hand is touched than it matters which eye is stimulated by an object of vision. To some extent we do do that with the hands, and some of us do it to a greater extent than others. When one does it he will naturally find it easier to tell the relation of the objects to one another than to his separate hands. If this were the only important function of the hands no doubt we should always be obliged to resort to some unusual procedure in order to tell which hand is stimulated. These two purposes sometimes conflict, and sometimes one and sometimes the other predominates. When a person has adjusted himself to observe the relation of the objects to one another he can judge direction more quickly, and when he has adjusted himself to observe the relation of the objects to his separate fingers he can more quickly judge the hand touched. We see here illustrated two quite different states of mind. The one regards the objects only, and the other regards the objects and the sense organs. The latter is made possible by the power of independent action of the hands.

With all subjects I noticed that it was much easier to recognize the sharp points when the points were not near together. When the points were on near fingers they would often ask to have them pressed harder, saying that they felt two points but could not tell which was the sharp one. When the points were

some distance apart no one ever asked to have them pressed harder, and every one could recognize the sharp point without difficulty. Occasionally I threw in an extra experiment in which I used two sharp points. Sometimes this was noticed and sometimes it was not. If the points were some distance apart it was sure to be noticed. In one series I threw in these extra experiments systematically, beginning with the points on adjacent fingers and gradually increasing the distance. These 'extras' were slipped in along with other experiments to which the subject was accustomed. He did not recognize that he was touched with two sharp points, instead of with one sharp and one blunt one, until four fingers intervened. There were nine stimulations of this sort given without recognition, and with the tenth four fingers intervened and he discovered that both points were sharp. This distance is unusually great. One may reasonably expect two sharp points to be perceived as sharp if two fingers intervene. They may be perceived even when on the same finger, but they are not so likely to be.

I tried a few series of experiments in which the subjects judged whether the sharp point was nearer or farther from the base of the fingers. This seemed very easy to do. Practically no mistakes were made, and no one seemed to have any difficulty in distinguishing which was the sharp point. This might seem contrary to the well-established fact that the so-called space threshold is greater in the longitudinal than in the transverse direction. But in making these contacts there was always a knuckle between the points, and the knuckles form a dividing line and it is easier to tell the difference between two points even on the same finger when separated by a knuckle than to tell the difference between two points on adjacent fingers when not separated by a knuckle.

One of the important factors in determining a judgment of the number of points touching the skin is the direction of the pressure. This in turn is affected by the form of the surface. If two points are placed on a curved surface, they must either press in a different direction or tend to pinch the skin slightly or to draw it slightly. This in part accounts for the smallness of the threshold on the nose. At the end of the nose two

points cannot be far apart without pressing the skin in different directions. Moreover, the threshold in the longitudinal direction is not so very small. It is no doubt smaller than it would be if it were not for the difference in the structure of the underlying tissue. On the middle line of the nose there is not very great power of discrimination in the comparatively homogeneous stretch between the bridge and the soft part. As soon, however, as one point is on the hard bone and the other on soft tissue, they can easily be distinguished by the qualitative difference. And if one of the points presses a little to one side and the other to the other, they pull the skin and are recognized as two. I have noticed when I have acted as subject that two points resting on the nose in a longitudinal line felt as if they were exactly opposite, one on either side of the median line. This was due to a slightly different direction of pressure, one pulling the skin one way and the other the other. In this case they were recognized as two at once, but that does not mean that they were beyond the longitudinal threshold. If they were beyond it they should not have felt as if they were transversely opposite. The transverse threshold is necessarily very small, because it is not possible to have the two points much distant without having a difference in the direction of the pressures. Difference in direction is equivalent to difference in quality of sensation; or perhaps it would be better to say that one sort of qualitative difference is difference in direction. I do not mean that where a certain kind of qualitative difference is present we are able to infer direction. I mean that the two are synonymous and that one is as ultimate a fact as is the other. However brilliant may be the attempts to reduce it to motor or other terms, the same old space relation is there as an ultimate fact when we get through.

Certain physiological processes are, of course, necessary in order that anything be perceived, and it is desirable to find out all we can about those processes, but nothing is gained by trying to substitute the process for the object of perception. The movements employed in *measuring* space are themselves objects of perception and hence may serve as a basis for comparisons. We may measure a room with a yard-stick, but we

do not reduce the room to a yard-stick. We use a stick because it is easy to carry about and serves as a means of comparison of different distances. In the absence of a stick we may step it off and thus make comparisons by means of movements. This comparison forms the basis for associations and thus aids perception. The movement of stepping off distances or of running the eyes or fingers over them is for purposes of comparison and description, and it aids perception in the same way that writing out a thought helps one to comprehend it more completely. Writing out a thought fixates the associations composing it, measuring a room with a yard-stick fixates its size, measuring it with eye movements does the same thing, only less accurately and perhaps less permanently. We would use sticks more and eye movements less if sticks were always available and as easily handled as are eye muscles.

In all of my experiments the actual space relation has been one of the chief elements of perception. It appears in two forms, distance and direction. Each supplements the other. When the distance is small the difference in direction must be greater, and when the difference in direction is slight the distance must be greater in order that two points can be perceived separately. The threshold for two points is not a space threshold, but rather a space-direction threshold. But even this is not sufficient to account for the perception of two things. So far as the immediate excitation is concerned they are the determining factors, but number is not given immediately. Associations must be formed before the idea of number arises. The formation of these associations is a very complicated process and is possible only to an intelligence of a very high order. Some writers conclude that birds can count because they notice it when eggs are taken from the nest. A bird may well know the difference between two eggs and four eggs without knowing anything about the *number* of eggs in either case. A bird may know the difference between a worm with twenty legs and a worm with none, but who would say that that is evidence that the bird knows how many legs the one has or that it has a *number* of legs at all? It happens that we distinguish the worms by other characteristics than the number of legs, while we dis-

tinguish the nests only by the difference in number of eggs. In this particular case the most convenient way of recognizing the difference is to note the number of eggs. This is the only way we can describe the difference, and the necessities of description have much to do with determining the perception. But to a bird the difference between a nest of two eggs and one of four may be as great as the difference between a bald head and a bushy one is to us. We could easily conceive a being to whom the only difference between a bald head and a bushy one was a difference in number of hairs. In fact, we might describe the difference in terms of number, but we do not perceive it that way. We describe a great many things in terms of number which we do not perceive that way. We may describe a square as having four sides and a circle as having an infinite number of sides, but no one needs to know the number of either in order to recognize the difference. I shall have more to say about the number concept on a later page. It is sufficient for the present if we bear in mind our inclination to read into perception attributes which we have found convenient for purposes of description.

I shall pass now to a consideration of the sense of sight and shall report the experiments made on that sense.

Introduction to Experiments on Vision.

Naturally, we should not expect to find exactly the same phenomena in connection with sight that we find in touch, for sight is a more highly developed sense. This necessitates different methods of experimenting, though it does not, at least *a priori*, necessitate different principles of explanation. There are two important differences between the organs of sight and those of touch. First, eye movements are always coördinated, while movements of the hands are coördinated only to a very slight degree. The two eyes always sense the same objects in the main part of the field of vision, the two hands may or may not. If we moved each eye independently of the other, we should have to adjust ourselves to objects in a very different manner from our present one. I have said that many errors of touch are errors of localization. I have said that one thing hat seems to occupy two places is called two, and that two

things which seem to occupy one place are called one. This is very familiar in the case of sight. Two pictures brought to the same place by a stereoscope look like one, and one picture seen in two places looks like two. If we train ourselves, as we easily can, to look with parallel vision, we see double when we look at one object, and we may seem to see but one when we look at two if they are properly placed. In order to see two things as one they must be just alike or nearly so, for otherwise there would be retinal rivalry; but this retinal rivalry is due to the fact that we know two things cannot occupy the same place at the same time. We cannot perceive a thing in a way that would be altogether impossible in nature. We may wear glasses which make things appear inverted, but there is nothing impossible in that. We see things inverted every time we look at the reflection in water. Retinal rivalry finds its parallel in touch when a sharp and a blunt object on the hand seem to be in the same place, only we can conceive a sharp point surrounded by a larger object, and in my experiments I found this was often done. In that case the rivalry disappeared, just as it does in stereoscopic vision when one picture is of such a size and nature that it can be conceived as existing within the other without destroying either picture.

A second difference is that the organs of sight are in constant motion, while the organs of touch may be kept still. Inasmuch as the hands are the most used organs of touch and my experiments were all made on them, I speak of them as if they were the only organs of touch, and for present purposes I shall consider that we feel with two hands as we see with two eyes and, for the most part, disregard the rest of the body. In our ordinary experiences we do not often realize how much depends on the constant movement of the eyes, but the moment we begin to experiment we must take it into account. It is comparatively easy for a subject to sit down and hold his hand still while the operator touches him with something, but it is impossible for him to keep his eyes still when something is shown him. They will move unless some extremely artificial means are used to prevent it. Such artificial means are not only inconvenient, but interfere so much with normal vision that they are undesir-

able. The only practicable way seems to be to make the exposure too short to allow much eye movement. This makes it necessary that the subject base his judgments on memory and not on direct perception. He has not time enough to form a judgment until after the stimulation has ceased. The sensation may endure for a short time after the light is shut off, but not so long as it usually takes to form a judgment. The after image may sometimes serve as a guide, but few persons are sufficiently well trained in observing after images to get any help from that source, and if they did it would not be exactly the same as a direct perception. Therefore, it seems evident that in the case of sight the judgment depends largely on memory. But so it does with touch. The stimulating objects may be left on the skin for a long time, but the subject names the most prominent contacts first and remembers them while he looks for others. He does not perceive them all at once as separate individuals. He has one advantage in touch in that he can go back over the field and verify his count by direct perception. He cannot do this with sight because the objects are no longer present. He cannot always do it with touch, for often some of the sensations fade away before he gets to them a second time.

The power of rapid and constant movement of the eyes is undoubtedly one of the causes of the high development of the sense of sight. The movement of the fingers over an object in feeling it corresponds to the movement of the eyes in looking at it. We are very familiar with the acuteness of the sense of touch when the fingers are moved over a surface. If a subject is allowed to move his fingers even a very little he can often tell how many contacts are on them, when he cannot tell without moving them. There is the same tendency to move in the fingers that there is in the eyes, but not to so great a degree. It requires special effort for some persons to hold the fingers still when they are trying to observe the number of contacts on them, but they can be held still more successfully than can the eyes. If the eyes are held even approximately still for a short time the objects before them blur. This applies when the objects themselves are stationary. Sensations of touch readily blur or fade if neither the hands nor the objects touching them

move. It may be true that we do not see objects when the eyes are in motion, but it is also true that we could not see objects well if the eyes remained stationary, unless the objects moved. Rapid alternation of movements and pauses seems to be the condition best fitted for seeing. The same is true of the fingers in feeling. When we want to feel a surface we move the fingers back and forth over it. This alternation produces repeated stimulations. Subjects get help often by pulling on the muscles of a finger even though there is no perceptible movement of the finger, and sometimes even when I could not detect any finger movement and the subject did not realize that he was using any of his muscles I have been able to see a tightening of the cords along the back of the hand when he was making special effort to perceive contacts on his fingers. This may help to direct the attention, and it certainly restimulates the part to some extent. This tendency to move in order to make sensations more distinct is conspicuous in sight, touch and taste, and is also present to some extent in smell and hearing, though in the two last-mentioned senses it is more noticeable in animals than in men. All of these movements increase the excitations of the end organs, and they may increase the sensitivity by increasing the blood supply. It may be that the remarkable sensitivity of the skin in the blind, and especially in the blind and deaf, is due to an acquired power of delicate movements, for delicate movements must make possible delicate and finely differentiated excitations.

A number of recent writers have laid great emphasis on the motor element in sensation, and the opinion is somewhat widespread that there can be no sensation without a response, and that the response determines the sensation and is a part of it. I have myself been an enthusiastic supporter of the view that an efferent process is as essential to sensation as the afferent process, and for some time I thought my own experiments confirmed that view, but after more careful consideration it seems to me that it is inadequate and rests on an incomplete consideration of the facts. In a recently published work on 'The Practice Curve'[1] Dr. J. H. Bair has taken that point of view

[1] PSYCHOLOGICAL REVIEW, Monograph Supplement, No. 19, November, 1902.

and has interpreted his results accordingly. The next few pages will be in part a criticism of his position.

If we imagine a bird soaring in circles above our heads, we no doubt find on introspection that the eyes tend to move in circles in much the same way as they would if we actually saw the bird. It might be argued from this and many other similar experiences that the idea and the movement are inseparably connected. If they are, what is the connection? Does one not think of the soaring bird before he moves his eyes? If I close my eyes and think of an object at my right I find my eyes tend to turn to the right, and then if I think of an object at my left I find my eyes tend to turn to the left. But why do they turn to the left, unless it is because I have first thought of something *there?* If, instead of thinking of an attractive or indifferent object, I think of a repulsive one, the eyes tend to turn away. Why should the eyes turn one way in one case and the other way in the other, unless some conception of the nature of the object is present in the mind before the movement takes place? If I know that my hat is on the table at my right and some one says 'hat' to me I tend to look or move toward the hat, but certainly there is nothing in the sound of the word or in the idea of the thing that could lead to movement in any particular direction. It could be nothing other than the consciousness of the position of the hat, and this consciousness must have preceded the movement. It is here an altogether accidental attribute of the hat which determines the response. I may never have reacted in that way to 'hat' before. The word in this case suggests position, and the position suggests the movement. The reaction is not called forth by the thing but by the space relation.

We sometimes say one cannot have an idea of a thing without having some idea of what he would do with it, or, more technically, without knowing how he would react toward it. The idea of cutting is inseparably connected with that of knife, but so is the idea of patent medicine inseparably connected with the Brooklyn Bridge. Cutting usually accompanies the knife and, unfortunately, patent medicine bill boards always accompany the bridge. The association of bodily movements

with mental states is no more intimate nor essential than association of external objects. It is no more significant in an explanation of conscious processes. The only difference between the two is this: We can control bodily movements and we cannot always control external objects. We try to reproduce situations when we think of them. If we imagine ourselves riding on horseback, we tend to reproduce the movements we have made while riding, because we *can* do that. If we could reproduce the horse as easily, no doubt we should do it, and then psychologists would have good grounds for concluding that one could not think of horseback riding without having a horse between his legs, or at least tending to have one there.

Mr. Bair, in the work referred to above, gives the following incident in support of his position. He says: [1] "The fact that the bodily adjustment, even though arbitrarily made, recalls to mind the feeling and experience usually connected with that adjustment is very prettily illustrated by a two-year-old child whose associations I have studied. Last summer her father took her with him fishing, and she was taught to show how big a 'fishy' papa caught by spreading her arms. One day six months later, when for a long time she had not shown any one how big the fish was, her father had her standing on his knee, when all of a sudden she lost her balance and threw out her arms to regain it. This adjustment called to her mind her former association and she exclaimed, 'O, papa, fishy, fishy!'"

This is an interesting example of childish association, but the fact that it was an attitude of the body which called forth the idea of 'fishy' is no more significant than if anything else had suggested it. Bodily movement is an object of perception as much as is a fish-pole, and either may suggest a fish, and the method of association is the same in either case. Nor do I regard it as significant that it was her own bodily attitude which suggested the fish. Some movement of her father might have served as well and in the same way called up the association. The body is a part of one's environment and as such affects us. If I draw down the corners of my mouth and look melancholy it tends to make me feel melancholy. But if I see

[1] Page 56.

another man looking that way that also tends to make me feel melancholy. Wherein lies the difference? In just this: I can raise the corners of *my* mouth if I try, and I cannot raise *his* by direct effort of the will. I may be able to affect him somewhat, but not so easily or quickly as I can my own body. Moreover, my own body is a *constant* element of my environment, and the matter of constancy has much to do with the amount of influence an object has. The reason we think of objects as located in relation to our own bodies is that our bodies are always present. If a post were always in a conspicuous place in every group of objects we perceive it would serve the same purpose just as well, and it would be a law of perception that things must be regarded as lying on one side or another of that post. If I see a stranger with the signs of sadness in his face the effect on me is comparatively slight, but the same signs seen in the face of a friend have a much greater influence merely because the friend has been more often a factor in my environment than has the stranger, and because I am more attached to him. Just so, I am still more attached to my own body because it is always present and has grown dear to me on account of associations. Sometimes, indeed, one can change his external environment more quickly than he can his bodily adjustments and mental equipment. Cases of sudden conversion often illustrate this. A man becomes deeply convicted of sin and is converted, and, having religious emotions in his soul but only campaign expressions in his mind, in a moment of ecstacy shouts out 'Hurrah for Jesus.' His motor response was not at all the correlate of his state of consciousness. He had the proper emotions, but the proper corresponding motor element was entirely lacking because he had not formed the necessary associations. Having reacted in the wrong way his reaction may become an object of thought, and influence his next thought and his next movement; but if he had thrown up his arms and knocked down a chandelier, the falling of the chandelier would also influence his next thought and his next reaction, and the question again comes forward, How does the influence of motor reactions differ from the influence of external events?

Last year I collected a large number of answers to the question, How many one-dollar bills will equal in weight a five-dollar gold piece?[1] I found that people are altogether unable to form a judgment. The average estimate was 2,291 bills and the median estimate was 45. The actual number required is a little less than seven. I intended by that question to show that we cannot form judgments about qualities toward which we have never consciously reacted. I would not now state it that way. The motor response to money has been exactly the same as it would have been if weight determined the value of both bills and gold, but we have formed different associations. We have not consciously reacted upon the weight of bills; but that word 'consciously' simply implies associations and does not imply any difference in the reaction.

A psychologist once told me that he could not form a mental picture of an elephant and at the same time put his vocal organs in the position to say dog. He gave this as an example of thinking in motor terms, or thought conditioned by motor adjustment. But the conclusion does not necessarily follow from the fact. Certainly it is just as logical and it seems to me more consistent with other facts to say that it means that he cannot think of dog and elephant at the same time. For, in order to make the motor adjustment necessary to pronounce the word dog he must think of dog, and that prevents him from thinking of elephant. In matters of speech, as well as other voluntary movements, we do not will the movement directly but will the result. The result in this case is the word dog, hence that word must be in mind, and the narrowness of consciousness may explain why one cannot consciously pronounce one word while thinking of another. We often do by a 'slip of the tongue' speak one word while thinking of another, but in that case the spoken word is not willed. The limitation is in the will and not in the vocal organs, because we cannot will an act without thinking of it.

In just the same way I should explain the fact, mentioned by Mr. Bair in his thesis, that people cannot repeat the words *one one one* and think *a b c*. When a person thinks *a b c* he

[1] Published in *Science*, April 25, 1902.

cannot think *one one one*, and hence cannot pronounce the words. There is an abundance of evidence to show that one cannot attend to two things at once unless they are related to each other so as to form some sort of a unit. We might represent visually the letter *a* and the figure 1 together, we may have seen them together. But we cannot pronounce the word *one* and the letter *a* at the same time, hence we have never associated them in simultaneous connection and cannot group them together, or in other words think of them as any sort of a unit.

We may grant that there is no thought without expression, or at least that thoughts tend to be expressed, but it does not follow that the expression is one of the conditions by which thought exists. Accidental attributes of a thing usually determine the response. Hat-on-the-floor calls forth a different response from hat-on-the-rack. The mere accidental position has little to do with the sensation produced by the hat and nothing whatever to do with its nature or function. Yet it is the position which determines the response. If it is on the floor, it is the incompatibility of its location and its function which determines the response. It is not thinking of a thing that leads to action, but thinking where the thing is. It is not so much thinking what we shall do with it as where we shall get it. If I close my eyes and think intently of a pencil on my desk I notice an inclination to reach for it, but I do not notice that thinking of the pencil makes me inclined to write with it, although pencils are made to write with, not to reach for, and I have spent more time writing with them than reaching for them. If I think intently of a knife lying beside the pencil I also feel impelled to reach for it, and I can discover no difference in the two responses, though the ideas of the two things are altogether different. I feel no more inclined to whittle with the knife than to write with the pencil. The thought of knife and pencil never impels me to sharpen the pencil and write. It is only the thought of something I wish to say that impels me to write. Bodily adjustments may help or hinder the flow of thought, but that has nothing to do with the response to the thought when it has once come. Mr. Bair says: "A person who is able to produce good compositions when writing may find difficulty in

thinking when writing on a typewriter," and regards that as evidence that "all our thoughts are accompanied by movements and are in turn conditioned by movements." It is quite true that one who is not accustomed to composing on a typewriter cannot do it easily. It is quite probable that many scientific men can write letters easily on a typewriter, but could not write a scientific article on one. Does that mean that they think their scientific thoughts in terms of pencil movements and their correspondence in terms of typewriter keys? I cannot conceive it that way. I find myself unable to do useful thinking while riding a wheel, but walking does not interfere with my thoughts. I do not, however, believe that this shows that my scientific meditations are conditioned by the steps I take and that the aimless reverie is conditioned by the movement of pedaling a wheel. It is only that I have made it a practice not to think much while riding, but when walking I do study. A student sometimes forms the habit of studying a certain subject in a particular room and is distracted if the furniture is rearranged or he is compelled to study that subject elsewhere. Our thoughts are as much conditioned by external environment as by bodily adjustment. I do not deny the effect of the motor system upon consciousness, but I maintain that its effect is due to the fact that a reaction is itself an object for sensation, rather than an element of sensation, and produces its effect in the same way that external objects do.

If a motor process is an essential element of sensation I cannot account for the fact that we can feel the movement of an object vibrating more rapidly than it would be possible to move the muscles. We feel each separate vibration but we react only to the series of vibrations and not to each separate one.

Another difficulty, which for me is insurmountable, is how it is possible to perceive a reflex movement itself. On this theory a sensation is the result of an afferent and an efferent nervous process. Then, in order to have a sensation of a reflex movement of one's own hand, it would be necessary first for an incoming current from the hand to reach some center and be reflected so as to produce a motor response. This response may not involve the muscles of the hand. It may be simple or

highly complex, but there must be a response. Then only would the sensation arise, but this sensation must also have some response, for otherwise it would not be a sensation, and the response must be made before there is a sensation. What was said of the first response may be said of the second and so on *ad infinitum*, and no sensation of a reflex movement can arise until the last member of an infinite series is reached, and considering the slowness of nerve processes it would take a very long time to have a real sensation of a movement if it had to come that way.

Experiments on Vision.

The apparatus used for the experiments on vision was the ordinary drop-screen. It was held up by a magnet, and the subject released it himself by changing the direction of the current with a pole changer. He was thus able to make the exposure exactly at the moment of maximum attention. Each one chose his own distance from the screen — usually from 18 to 30 inches. The opening in the screen was wide enough to make an exposure of one one-hundredth of a second. A white card three centimeters wide was placed behind it, and on this card were drawn lines or dots and the subject was asked to judge the number. The figures reproduced (see Plate I. at end) show approximately the size of the lines used. Heavier lines are perceived more readily and accurately, and lighter ones are perceived less accurately. Each card was exposed three times in succession, thus giving the subject an opportunity to correct his first statement if he chose. He recorded his judgment of the number every time the card was shown, and in working out the results I took the sum of the three. Space was left on the paper for him to draw the objects as he saw them. He did this partly as an aid to himself and partly as suggestions for the experimenter. He was not required to draw them every time, but was free to do whatever was most helpful to him. Most subjects drew the figures quite often, especially when something new was shown them. They often found it necessary to make the marks on paper as they appeared to them and then to count them before assigning a number.

The first set of experiments was planned for the purpose of showing that increase of complexity does not imply increase in difficulty of judging, or it would be more in accord with my point of view to say that increasing the number of parts does not, of itself, increase the complexity of the sensation produced by it. This was very evident in the sense of touch.[1] For this purpose figures B, C, D, F and G were made. There were five cards in each series, the only difference in the cards of a single series being a difference in the distance between the lines. The lines were three millimeters long and the space between them was 2 mm. on the first card, 4 mm. on the second, and so on, up to 10 mm. on the fifth card. For this particular experiment there was really nothing gained by having so many cards of the same kind, as the variation in distance made no difference. But before I began I thought perhaps the distance might have something to do with the judgment. Even at the greatest distance the lines were within the field of distinct vision, and perhaps one should not expect any variation in perception. The fact that there is no difference, however, will be significant when compared with some results which will be given on a later page. Figure B is made up of the smallest number of lines, and hence is the simplest. Figure C has twice the number of lines, making it just twice as complex. It consists of a pair of lines just like figure B, plus another pair of the same kind, except drawn in the vertical instead of the horizontal direction. If small numbers are easier to perceive than larger ones, then B should be perceived more easily than C; but if we find that adding two lines does not make it more difficult to perceive, or if it makes it easier to perceive, then an explanation must be based on some other factor than difference in complexity. If C is more easily perceived than B, it may be because the addition of two lines makes it blacker and hence more visible, just as several small dots are visible at a distance when only two or three of them by themselves could not be seen at all. This matter can be tested by the use of figure D. It is just as black as figure C. It consists of the same number of lines running in the same direction but not bearing the same

[1] *Harvard Psychological Studies*, Vol. I., page 139.

relation to one another, hence the figure is quite different. If C is more easily perceived than B on account of being blacker, D should be perceived just as easily as C, for it is just as black. If vertical lines are more easily perceived than horizontal, or if lines running in two directions are more easily perceived than lines running in one direction, C might be more easily seen than B, but there could be no difference between C and D on that basis.

TABLE I.

	Ba	*Ca*	*M*	*Fa*	*H*	*G*	Av.
B	50	70	35	34	54	50	49
C	5	37	16	20	5	13	16
D	9	69	52	72	50	27	46

The accompanying Table I. contains the results obtained from figures B, C and D in terms of percentage of error. The vertical columns show the average errors for six subjects, and the horizontal rows afford a comparison of the three figures. The last column contains the final averages for each figure. There is a slight inaccuracy in the results, brought about by the fact that some of the errors were errors of overestimation and some were errors of underestimation. In adding up the results for each individual subject an overestimation sometimes offset an underestimation, but I do not think this occurred often enough to make it necessary to complicate the table by showing these variations. Figure D was overestimated only once, figure C but few times, figure B more often. One subject, given in the table as *Ba*, overestimated B very often, so that his actual errors were more than the 50 per cent. attributed to him in the table. But since the final average is an average of individual averages, these cases do not affect it to any great extent. It may make a difference of one or two per cent. in the average for figure B, which would not change the significance of the results.

It will be noticed that the errors for B and D are about three times as great as for C. All subjects said that figure C was much easier to perceive than either of the others, and the tabulated results agree fully with their subjective reports. There was much less feeling of uncertainty and much less hesitation

in answering when series C was given. A comparison of the number of errors in series B with those in series D shows approximately no difference. We may then rule out those factors mentioned above, blackness and direction of lines, as having nothing to do with the judgment of number, and we must conclude that the form of the figure as a whole is the important factor.

A comparison of figures F and G will throw some light on the question of form. Here there are two things to consider, the amount of error and the nature of it. Instead of giving the percentage of errors I will give the total number of lines perceived by each subject. No subject except *Ba* saw either of these series more than once. There were five cards in each series and each card was shown three times, but when the whole set had once been given it was not repeated at another sitting. *Ba* was given the same thing on four different days. In his case I give the average for the four days. It will be noticed that the actual number of lines seen in series F is 75 and the actual number seen in series G is 120. Table II. contains the total number of lines reported by each subject.

TABLE II.

	Ba	*K*	*Ca*	*M*	*H*	*G*	*F*	*A*	*S*	Av.	Av. Error.	Per cent. Perceived.
F	94	144	49	53	114	72	45	108	98	86.3	29	1.15
G	119	149	70	94	118	105	112	112	111	110	17	.91

The first thing observed is that the average estimate of the number of lines in series F is above the actual number, while in series G the average estimate is below the actual number; and the difference between the average estimate and the actual number is greater for series F than for series G. In the former the total number of lines reported by the subjects is 115 per cent. of the number given, and in the latter the total number of lines reported is 91 per cent. of the number given. More significant still is the average error, which for series F is 29 and for series G is 17. Not only is the average error less for series G, but the direction of the error is practically uni-

form. Only one subject overestimates series G. All the others underestimate it with some degree of uniformity. Six of the remaining eight are quite uniform, and only one, *Ca*, is greatly below the rest. In series F five overestimate and four underestimate, and there is scarcely any uniformity. The mean variation from the average error is practically the same foı both. It was not really necessary to carry out these figures; a glance at the table is sufficient. Uncertainty and variability characterize the judgments in series F, while much greater accuracy and more uniformity are found in series G. The reason is not hard to see. The lines in figure G make a complete figure. Figure F is the same thing with three lines left off. It would be a complete and symmetrical figure if turned around so that the two lines running in the same direction formed a base, but as it stands it suggests something like figure G but yet there is something lacking and it is hard for the subject to discover what is wrong. At one time it looks like one thing and at another time like something else, and he cannot make out what it is. As mentioned above, the variation in the distance of the lines from the center had no effect on perception. The same card might just as well have been given fifteen times in succession except that the subjects knew that the cards were changed and hence knew that there might be a difference. It will be seen that subjects *K*, *H* and *A* saw no appreciable difference between the two series. They seemed to get the idea of a group of lines arranged about as they are in G, and they would often draw the figure as they seemed to see it and then count the lines. Some subjects noticed that the figure was incomplete and would make some allowance for the gap at the lower left-hand corner, but they could not tell how much allowance to make. Still others were unable to get an idea of any definite figure out of it. They knew there were a few lines, but were always very uncertain of the number. They were quite sure to underestimate. We can easily see why subjects tend either to overestimate considerably or to underestimate considerably. Some are quite ready to fill out the missing places and think they see them. They give their attention chiefly to the part they actually see and supply the rest, just as

we habitually supply missing parts in the field of vision. Others notice the gap, and in their efforts to make out with certainty what is there and what is not, give more attention to the missing part, and being careful not to report any more than they are sure are there, fail to see all, and underestimate the number.

With series G there was much less feeling of uncertainty. It was not unusual for a person to regard the figure as consisting of six lines instead of eight, in which case it would be symmetrical and complete and in form much as it actually is. Occasionally only part of it seemed to be seen, and it would be drawn in a way more or less similar to figure F. It makes a great difference what the subject attends to. He attends to the thing as a whole if it has enough unity to enable him to do it. If it has not or if he fails to grasp it as a unit, he must attend to one part of it and infer that the other part is what he would naturally expect it to be, or he must attend to one part, and refusing to trust to inference for the other, report what he does see and make no account of the other part.

One might say that it is easier to perceive a number of objects when arranged with regularity than it is when they are not so arranged. That is true to some extent and under some circumstances, but one could arrange a set of experiments which would seem to disprove it, or perhaps to prove the opposite. I made a few experiments bearing on this question. For this I used dots, from 5 to 20 in a group, instead of lines, and compared the judgments of the number of dots regularly arranged with the judgments of the same number irregularly arranged. The observers felt less certainty when the dots were in irregular order, and made a greater number of errors. About all they could do was to get some notion of the quantity and then reason out how many it would take to make up such a quantity. This they could do surprisingly well but, of course, they were likely to make slight errors the most of the time. When the dots were in regular order they did not make so many mistakes, but when they did they were quite likely to make greater ones. For example, nine dots in irregular order were never judged to be more than twelve, but the same number of dots arranged in three rows of three dots each was called sixteen. The observer recog-

nized a square group of dots, but he thought it consisted of four rows with four dots in each row. This made him estimate the number as nearly twice what it actually was.

In all there were 186 judgments given by four subjects. One half of these judgments were of regular and the other half of irregular groups. Counting up the total *number* of errors made, I find that out of the 93 judgments of regular groups there were 42 erroneous answers, and that out of the 93 judgments of irregular groups there were 51 erroneous answers. But when I figure up the total *amount* of error I find that the 42 wrong answers about regular groups contain a total error of 160 dots, or an average of 3.8 dots per wrong answer; and 51 wrong answers about irregular groups contain a total error of 149 dots, or an average of 2.9 dots per wrong answer. In other words, the number of errors bears the ratio of 4 to 5 approximately, and the amount of error the ratio of 4 to 3.

I shall make further use of this experiment in the conclusions which will follow the experiments. For the present it may help to show that the difference between series F and series G is not due to the fact that one figure is regular and the other, though in reality regular, does not give the impression of regularity. The difficulty of judging the number of objects in a group must involve other factors than the number of objects and the regularity of their arrangement.

It will be useful to know if a number of objects bunched close together is perceived with greater or less difficulty than is the same number when scattered over more surface. I prepared four sets of cards bearing respectively 8, 9, 12 and 15 dots of about one millimeter in diameter. Each set contained three cards. On one the dots were very close together, on another they were scattered as much as the apparatus would permit, and the third card was a medium between the two, as nearly as I could make it. No accurate measurement of distance was possible, as no two were alike and I tried to arrange the dots as irregularly as possible. Each card was shown three times in succession, as in the previous experiments; thus each observer made 36 judgments. Table III. contains the results for five subjects. The figures represent the number of errors made.

The amount of the error in each case is not taken into account. The direction of the error is indicated by the sign before each figure: — means underestimation, + means overestimation. C, M, and S at the top of the columns mean close, medium and scattered, respectively.

TABLE III.

	C.	M.	S.
Mi	+ 1 — 11	+ 1 — 8	+ 3 — 4
M	+ 1 — 6	+ 9 — 0	+ 5 — 1
A	+ 0 — 10	+ 5 — 0	+ 6 — 0
Ba	+ 1 — 7	+ 6 — 2	+ 12 — 0
J	+ 7 — 4	+ 7 — 1	+ 10 — 2
Total.	+ 10 — 38	+ 28 — 11	+ 36 — 7
Total Errors.	48	39	43

It will be seen at once that the number of errors is approximately the same however the dots are distributed. The difference between 48, 39 and 43 is not enough to be considered. The subjects themselves seemed to regard one kind of distribution as about as easy to perceive as another. The significant fact is that the errors of underestimation decrease as the dots become more scattered and the errors of overestimation increase. One increases just about as rapidly as the other decreases. One might expect that there would be fewer errors in the medium group than in either of the others. If instead of counting the number of errors we take the total number of dots shown and compare with the total number reported by the subjects, the underestimations would offset the overestimations, and the remaining error would be comparatively slight. I made this calculation and found that the algebraic sums of the errors were as follows: Close — 67, medium + 39, scattered + 71. The total number of dots shown in each group was 660. When they were close together they were reported as 593, when they were somewhat scattered they were reported as 699, when further

scattered they were reported as 731. These figures are the totals for the five subjects.

If we could say, as these results seem to indicate, that the closer objects are together the fewer they appear to be, and that they appear to increase in number in proportion to the increase in distance between them, we should say that I did not succeed in making the medium group a real medium, but that the dots were scattered a little more than they should be. It would have been better, probably, if the dots in the medium group had not been scattered quite so much. It is going too far, however, to say that the apparent number increases in proportion to the distance. It does in a general way under certain conditions. It is a common practice to spread things out when we want to make them appear more numerous than they are. Men marching in a procession scatter out when they wish to appear like a great number. But if distance always produced this effect, lines arranged as they are in figure G should appear more when they are 10 mm. apart than when they are 2 mm. apart. Distance is an important factor when working by itself. It may or may not be an important factor when in company with other factors which may outweigh it.

In order to test further the influence of distribution and at the same time discover whether the size of the objects had any influence upon the judgments of number, a new series of cards was prepared. There were nine cards, each containing fifteen spots. The spots were of three sizes and arranged according to three different methods of distribution. The first card had on it small spots close together, the next small spots slightly scattered, and the third small spots still more scattered. The next three cards contained spots which were a little larger and arranged according to the same order of distribution. The last three contained still larger spots in the same order. Aside from the matter of distance between the spots regularity was avoided as far as possible. Figure O is an exact reproduction of three of the cards, showing the three sizes of spots and the three different distances apart. No. 1 represents the smallest spots close together, No. 5 the middle size spots at the medium distance apart and No. 9 the largest spots at the greatest distance.

Each of the nine cards was shown three times by the same method used in the previous experiments. The order in which the cards were shown was (1) close together, *a* small, *b* middle size, *c* large; (2) medium distribution, in the same order of size; (3) scattered, in the same order of size. The comparatively low estimates of the groups of dots close together might be due to the fact that they were shown first and the observers had not become familiar with the experiment, and hence they could judge the later ones better because of the training they had had. To avoid being misled by this, I repeated the first three cards at the end of the series without the subjects knowing that they were the same cards they had seen at first.

It will be noticed that the records may be worked over in two different ways. Tables IV. and V. contain the results worked out according to distribution and according to size. The figures represent the sum of each observer's judgments for each class. In the last three columns, where size only is considered, the repeated series is added in with the rest. Each card shown three times makes 45 spots shown on each card, and three cards in a group makes 135 spots shown altogether in each group. When size alone counted, three of the cards were shown six times and the other six cards three times, so that the correct answer for the total would be 180. With *Ba* the experiment was repeated at a later date..

TABLE IV. TABLE V.

	Close.	Medium.	Scat.	Close Repeated.	Small.	Middle.	Large.
Mi	110	132	134	122	174	171	153
F	97	116	132		115	112	118
Ba	136	162	152	132	174	192	216
Ca	83	93	105	81	96	119	127
J	115	134	139	128	175	173	168
A	141	163	151	134	186	201	206
G	93	112	119	111	134	145	156
Ba	123	157	164	117	184	171	206
Ave.	112	133	137	117	154	160	168

Table IV. shows a gradual increase in number as the distance increases. There are but two exceptions: *Ba*, at his first sitting, and *A* report a greater number at the medium distance

than at the greatest distance. There are no exceptions in the first two columns. For all other observers there is an increase in each case, and necessarily the average increases. In the column containing the results of the repetition of the first group it can be seen that in no case is the figure as large as the corresponding figure in the second column. Although the average is a little larger than the average of the first column, it is much smaller than the average of the second column. By accident the group was not repeated for F.

Table V. shows a tendency to increase when the size increases, but the increase is not so marked as in Table IV., and six exceptions to the rule will be found. In Table IV. the increase of column two over column one is 18.8 per cent., and of column three over column two is 3 per cent. In Table V. the increase of column two over column one is 3.9 per cent. and of column three over column two is 5 per cent. This difference is what we should expect if we consider the chief factors which determine the judgment. Experience teaches us that a large space will hold more things than a small one, therefore if we have no other data than the amount of space occupied we conclude that the greater space contains the greater number. This is not always true, and when we have time enough we count and see, and even if we do not have time enough to count, we may make some allowance for the empty spaces between the objects, but the attention is directed chiefly to the objects and not to the spaces between them, and hence we are not likely to make sufficient allowance for the spaces. This seems to me to be the reason that the subjects think the groups most widely scattered contain the greatest numbers. The first thing that attracts attention when a card is shown is a group of spots occupying a certain amount of space, and the second thing is that these spots are separated from one another by certain distances. This second factor, being less prominent, has less influence on the perception, and hence it is not given sufficient importance in making the judgment.

When size is taken into account the case is somewhat different. The larger objects give the idea of moreness, but this is counterbalanced by the knowledge that into a given space there

can be put a greater number of small objects than of large ones. In neither case does the observer perceive the number, but he perceives a group possessing certain characteristics, and from these characteristics he infers the number. He probably never gives the same amount of attention to each characteristic, and, as one or the other is more prominent in his mind, his judgment is influenced in the corresponding direction. Concerning the method of inference, more will be said later.

Table VI., given below, illustrates very well one method of inferring number. Two cards, represented in the cuts as figures X and Y, were used. X was shown first, and the observer perceived the crosses, estimated their number and doubled it to get the number of lines. Y was then shown, and as it did not contain crosses there was no occasion for doubling. The amount of surface covered was exactly the same as in X. The natural conclusion is that there are not so many lines in figure Y as in figure X. There were five subjects. On three of them the experiment was made but once, and on one it was made twice on different days, and on the other, three times on different days. I give the results in full. The three columns represent the three successive judgments which each subject made.

TABLE VI.

J	X— Y—	30 12	30 15	30 15
T	X— Y—	48 30	48 30	48 36
A	X— Y—	30 15	30 20	29 25
M	X— Y—	40 20	40 20	40 20
M	X— Y—	40 20	40 20	40 20
Ba	X— Y—	18 12	24 12	24 12
Ba	X— Y—	24 16	24 16	24 16
Ba	X— Y—	24 12	24 12	24 16

The actual number of lines on each card is thirty. It will be noticed that some of the answers are correct and many are

incorrect. The accuracy of the answers matters but little, the point is to compare the judgments of X with those of Y. In general the records show that the number of lines in X is regarded as about twice the number that are in Y. This is a legitimate conclusion from the *prominent characteristics* of the two figures. If the observer had time to attend to *all* the characteristics of course he could judge better, but he cannot attend to all of them at once, and he must base his judgment on those prominent characteristics which he can observe. The experiment shows in part the method of inference, and it shows the necessity of perceiving prominent elements first and drawing conclusions from them.

In order to reduce the matter to very simple terms a little experiment was tried, which it is not necessary to report in detail. I mention the total result as obtained from eight subjects. Two cards were prepared, each having four lines on it, thus, (1) — — — — (2) | | | |. The lines were the same size and the distance covered by them the same in each case. They were first shown in the position indicated and then turned around so that what is here the horizontal direction became the vertical. Each card was shown, in all, sixty times in each position. The sum of the answers given for the two cards in the horizontal position was 493, in the vertical position 534. This may be related to the tendency to overestimate distance in the vertical direction. If the distance did seem greater it would be natural to estimate the number as more, according to the preceding experiments. The sum of the answers for card (1) in the two positions was 484, of card (2) in the two positions 543. The correct answer in each case would be 480. Each card was estimated as more in the vertical position. (1) was given as 230 horizontal and as 254 vertical. (2) was given as 263 horizontal and as 280 vertical.

It seems to me that here is clearly indicated one of the relations of number and space. Every one knows that a vertical column appears longer than a horizontal one of the same length. It seems also that when the vertical column is made up of separate units it appears to contain more of them. We must conclude one of two things: either the perception of num-

ber depends upon something which is analogous to the reasoning process, or the perception of number and the perception of space are conditioned by some common element. We might borrow a mathematical expression and say that one is a function of the other, and ignore the causal element, but such a statement is unsatisfactory because it fails to take account of all of the facts. We can say that one tends to vary as the other varies, but the tendency is sometimes overcome by other influences. Filled space tends to look larger than empty space, but even this is true only under certain conditions. Considering all the conditions and reservations it seems best to fall back on the hypothesis that the perception of number is analogous to the reasoning process. That process will be the main subject for consideration in the concluding remarks of this paper.

Plate II. affords an illustration of the effect of distribution on the perception of size. To most persons the upper circle appears larger than the lower. They are the same size and contain the same number of spots, but in one the spots are more scattered. To some persons the spots themselves look larger in the upper circle. For some observers the illusion quickly disappears, for others it continues much longer. When squares instead of circles are used the illusion is just as marked. It is more noticeable and more lasting if, instead of using lines to bound the spaces, two separate pieces of paper are cut out and spots arranged on them in the same way. One of these circles is filled with as many things as the other but it does not seem to be as *much* filled. One suggests expansion, the other contraction, but I see no reason for thinking there is any more eye-movement in one case than in the other, especially as the illusion is the more noticeable the quicker the glance. A careful comparison of the diameters of the circles causes it to disappear.

Conclusion.

The perception of time and the perception of space have been studied and discussed at great length, but the perception of number as such has received but little attention. Much has been written about the logic and function of the number series, anthropologists have sought to discover the origin of numerical

systems, the question of multiplicity in unity has been discussed by philosophers, and psychologists have tried to find out how many things we can perceive at once, but seldom has the question been asked: How do we know how many things are before us when we do perceive them at once?

I would be glad if we had a satisfactory term to apply to those apperceptive processes which when described seem like reasoning, but which when experienced are not like it. If it were not for the logical implications of the term I would call it immediate inference, *i. e.*, it is immediate in the sense that the middle term is not present to consciousness. Middle terms have been used in developing the concepts but are afterward forgotten. Perception itself might be described as a reasoning process in which the middle term is so completely forgotten that it cannot be directly discovered. For the want of any other I am compelled to use logical terms, but I do not at all mean to imply that the observer is aware of the elements which he himself uses in making his judgments. When I say that number is an inference, I mean that it is inferred in the same sense that the third dimension is inferred and apparently directly sensed. Psychologists have explained the process of perceiving depth, and when stated it much resembles reasoning, but the observer is not aware of the *quasi* reasoning process, nor can he discover it directly. No one can directly discover that the retinal image of a distant object is smaller than the image of a nearby object of the same size. Illusions of distance are common and we attribute them to wrong interpretations of sensation. Artists give the impression of depth by foreshortening certain lines. As the process of perceiving space has been studied and analyzed and the main elements of it described, so I have tried to study the process of perceiving number. If the size of the retinal image and other elements of experience lead us to think that one object is nearer to or farther than another, perhaps there are elements of experience which lead us to think that one group of objects is more numerous than another. The experiments described indicate what some of these elements are.

The most obvious feature is the similarity of the process of perceiving number and the process of perceiving space. Just

as space is an original element in consciousness, but spaces, *i. e.*, space relations, are the product of experience, so number may be called an original element, while numbers are derived. The original space perception must be one of purely indefinite space. It cannot be called the perception of an amount of space, because *amount* implies relation and comparison, and there is nothing with which to compare the originally given space. Whether the object be a speck of dust or a mountain, its spatial quality is the same, and hence it is impossible in any way to designate such a space. We have much the same difficulty with number. We have no difficulty in seeing what the first perception must be numerically, but we have become so accustomed to thinking of number as some particular part of the number series that when we say *one* we cannot think of it except in its relations in that series. The term unit is better in some respects, but we usually think of that as meaning the smallest part into which some quantity is divided. When I say that what is given at once is given as *one*, I do not mean one in the sense of a primary component of a larger group. I mean simply an undivided whole. This whole may be separated into parts and one part after another may become an object of consciousness, and by setting these parts into correspondence with a previously constructed number series we may enable ourselves to remember in the future into how many parts we have found it convenient to separate this whole. Thus it becomes possible to assign the proper number to a given group without stopping to count, which means regarding one thing after another. This does not mean that we perceive the number of things in a group. It means that we perceive the group as a unit and remember that one of its characteristics is that it can be separated with advantage into a certain number of parts. One can immediately recognize a cube as a six-sided figure, but he does not perceive the six sides at once. There is no constant objective standard of unity. Sometimes one thing and sometimes another determines the point at which analysis shall stop. Continuity in space affords, perhaps, the most common basis of unity, but it is not enough in itself. The necessities of description often determine the limit of analysis.

No one could regard a cube as having seven sides instead of six, but that is because he has already limited himself by defining *side*. If one is asked how many parts there are to a cube he may as well say eighteen — counting surfaces and edges — and he need not stop here, he may as well include the angles, and so on as far as the acuteness of his own intellect will permit him to go. How far the analysis might be carried in any particular case matters not, the process is the essential thing. The process in brief is this: (1) The perception of an undivided whole, (2) the analysis of that whole into parts — this involves temporal succession, (3) setting the parts into a correspondence with the number series for the convenience of description and fixation by association. When this has been done enough times to firmly establish the association the process is no longer necessary, and the observer may come to think he directly perceives the number. When a group is presented to him he at once associates that impression with the number which he has assigned to it before. This act is nothing more than naming it. The only difference is that names are usually without connotation, while number connotes certain qualities. If names carry with them some significance, then there is no difference whatever. Both the name and the number connote qualities which need not be recognized or even remembered at the moment. One may recognize a horse as a quadruped without at the same time thinking that he is four-footed. One may recognize four lines as four without thinking of them as one and one and one and one. If he is asked how he knows it is four, he must say because he remembers that that unit is of the sort that he has separated into four parts and he has habitually regarded it as four. Four is a name for a certain object of sensation, and for sensation it is a unit, but a unit of such a character that it can be separated into parts and each part in turn become an object of sensation. If this separation does not take place the object remains a unit no matter by what number it is designated.

When figure G was given it was usually recognized as a thing of a certain form and that form is known by experience to consist of a certain number of parts. Sometimes it was necessary to make a drawing of it in order to count the parts (see page

30). By this method the observers were often able to give the correct answer. Evidently they had a picture of the *thing* in mind before beginning to draw, but that picture was not made up of parts. It was a unit which could be divided into parts. So far as a description of the object is concerned these two expressions amount to the same thing, but as a description of mental content they are altogether different. We see the same procedure exemplified in all the experiments. That which represents a thing, *i. e.*, has a known form, is associated with the number which describes its parts. Figure C was easy to recognize because of the familiarity of its form. Figure D conveyed less definite suggestions, and hence was not perceived so accurately. Figure B was very simple in form but less familiar than C, and as familiarity rather than simplicity determines the ease of judgment[1] we should expect it to be seen less accurately. Figure F was difficult because it suggested a form which it did not possess.

If the observer perceived the lines as lines, there is no reason why he should not perceive five as easily as eight, and he should do so more easily, but if he perceives a *thing* and associates some idea with it, then the more frequent the association the more easily is it made. This explanation at first sight may not seem to account for the perception of a group of irregular dots which do not form a familiar thing at all. They do not possess a form which can be named, and it may not be exactly like anything that has been seen before, but the group nevertheless does possess unity, form and a certain amount of familiarity. It is a little bunch of objects occupying a certain amount of space, it is more or less compact or diffused and hence has a quantitative character. We have, in a general way at least, associated number and quantity, and the judgments of number were based on just these elements when no others were present, or when the others were less prominent. A comparison of figures X and Y shows an extreme case of dependence upon the space-quantity relation. This must be depended upon when better means are not afforded, or when other factors are less prominent. In the experiments on touch it was found that

[1] See *Harvard Studies*, p. 138.

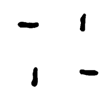
the subjects always mentioned the prominent points first and then looked for the others. This could be done in the touch experiments because the stimulation was of longer duration. In the experiments on sight the stimulus was removed so quickly that there was no time to look for factors not seen at first.

In the comparison of the regular and irregular figures it was seen that the form was the *prominent characteristic* in the regular figures. That is, we depend chiefly on form whenever it is definite enough to be recognized. We saw too that, although we are less likely to make errors when the figure is regular, if we do make them they are likely to be greater, because it is not possible to add or subtract just a little from a given form without thereby changing the form, hence when an error is made it must be great enough to preserve the form providing the form is recognized. Sometimes an observer would mistake one form for another. A figure whose vertical length was greater than the horizontal might be drawn with the horizontal length greater, and *vice versa*. This may have been due to poor memory. The actual form might be recognized but its position forgotten. The error is similar to the common error in touch in which the observer recognizes the number of points but locates them in the wrong direction.

Enough has perhaps been said about the method of analyzing objects of sensation and of assigning numbers to them by association. There remains but to mention the reason we analyze things according to their space relations so much more often and more closely than we do according to their qualitative differences. The 'vital question' with every one is not *what* things are, but *where* they are. Even the scientist, who, more than any one else, is interested in the *what* of things, spends the most of his time studying their space relations. The microscope is of service for this only. Eye-glasses prevent misconceptions of space relations. The person who is color-blind loses but little, but if a person were unable to perceive space relations he would be unable to live, merely because he could not find out *where to get* things.

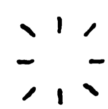
B

C



D

F



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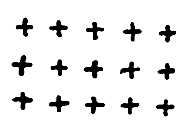

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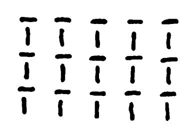
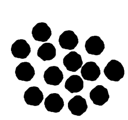
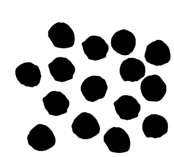


Y



O (1)



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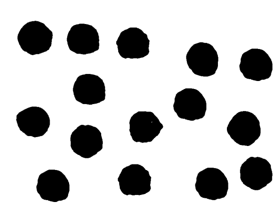
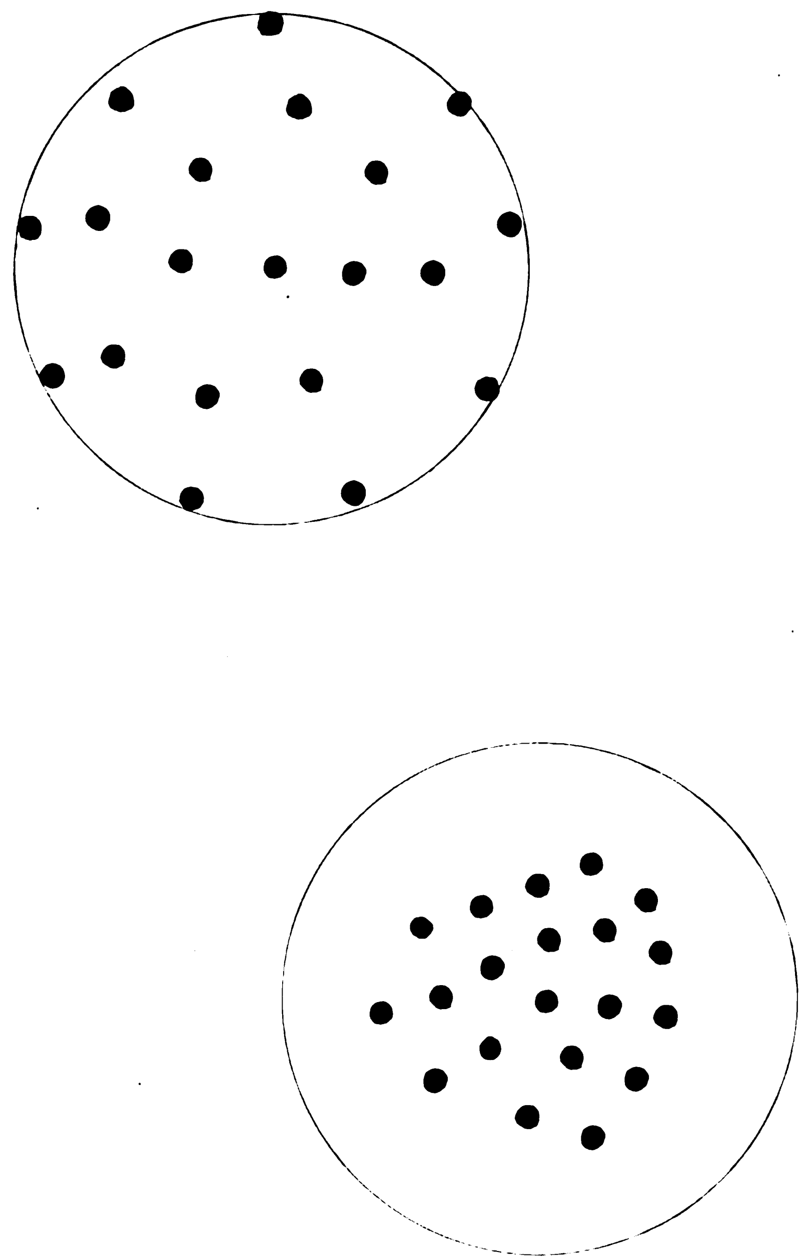


O (9)



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